PB-215 549

INTERSTATE AIR POLLUTION STUDY. PHASE II PROJECT REPORT. III. AIR QUALITY MEASUREMENTS

J. R. Farmer, et al

National Center for Air Pollution Control
Cincinnati, Ohio

December 1966

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PHASE II PROJECT REPORT

III. AIR QUALITY MEASUREMENTS

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INTERSTATE AIR POLLUTION STUDY
PHASE II PROJECT REPORT

III. AIR QUALITY MEASUREMENTS

prepared by

J. R. Farmer
J. D. Williams

Details of illustrations in
this document may be better
studied on microfiche.

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Bureau of Disease Prevention and Environmental Control
National Center for Air Pollution Control
Cincinnati, Ohio

December 1966

Copies of this report are available from the cooperating agencies listed on the cover of this report and from the Control Development Program, National Center for Air Pollution Control, 1055 Laidlaw Avenue, Cincinnati, Ohio 45237.

FOREWORD

The Interstate Air Pollution Study was divided into two phases. Phase I, a general study of the overall air pollution problems in the St. Louis - East St. Louis metropolitan area, was conducted to determine specific activities that would require further study in Phase II of the project. The effort was divided into two phases to provide a logical stopping point in the event that interest and resources for proceeding further might not materialize. The necessary impetus did continue, however, and the Phase II operation was also completed.

The Phase I operation resulted in a detailed report, designed primarily for use of the Executive Committee members and their agencies in making decisions concerning the Phase II project operation. A Phase I summary report was also prepared; it received wide distribution.

Numerous papers, brochures, and reports were prepared during Phase II operations, as were some 18 Memorandums of Information and Instruction concerning the project. All of these documents were drawn upon in the preparation of the Phase II project report. The Phase II project report consists of eight separate volumes under the following titles:

I. Introduction
II. Air Pollutant Emission Inventory
III. Air Quality Measurements
IV. Odors - Results of Surveys
V. Meteorology and Topography
VI. Effects of Air Pollution
VII. Opinion Surveys and Air Quality Statistical Relationships
VIII. Proposal for an Air Resource Management Program.

ACKNOWLEDGMENTS

Grateful appreciation is extended to these individuals and agencies whose cooperation and generous giving of their time, effort, and facilities made possible this Study and this report.

Dr. Nicholas Duffet,[a] Director, Public Health Laboratory, City of St. Louis Health Division.

Richard Collins,[b] Chief Chemist, Public Health Laboratory, City of St. Louis Health Division, and staff for invaluable assistance in performing chemical analyses and in providing laboratory facilities and equipment.

H. C. Mitchell, Director, Division of Sanitation, and William Shenk, Chemist, and staff of the St. Louis County Health Department for providing assistance and chemical analyses.

Don Long, Environmental Services, Missouri Division of Health, and staff for important chemical analyses.

Robert Scott, James Weart, and Arnold Westerhold, and staff of the Illinois Department of Public Health, Division of Laboratories, for important chemical analyses.

Anton Telford,[c] Industrial Hygiene Section, City of St. Louis Health Division, for operating a complete sampling station and equipment at other locations.

Robert J. Chanslor,[d] Supervisor of Air Pollution Control, East St. Louis, for operating a complete sampling station and other assistance.

Carlton Laird,[e] Wood River City Manager, and Anthony Candela, John Barach, Robert Stocker, Gene Rice, Ervin Thien, Wood River Fire Department, for operating and maintaining high-volume and AISI samplers.

Leo Sauget, Mayor of Monsanto, Ted Turner, Chief of Police, and Ollie Reeves, Monsanto Fire Department, for operating and maintaining high-volume and AISI samplers.

V. E. Staff, Chief Highway Engineer, State of Illinois, William S. Krause, District Engineer, W. B. Williams, and P. Ayers, for assisting the Study and operating high-volume and AISI samplers.

Robert H. Frey, Jefferson Barracks Veterans Administration Hospital, for operating and maintaining high-volume and AISI samplers.

[a] Presently Director of Laboratories, Board of Health, State of Kansas.
[b] Presently with St. Louis County Health Department.
[c] Presently with Illinois Department of Public Health.
[d] Presently with U.S. Public Health Service, Gary, Indiana.
[e] Presently with City of East St. Louis.

C. D. Trowbridge, Director, St. Louis Testing Laboratories, Inc., and Edward Lanser, Chemist, for operating and maintaining high-volume and oxidant samplers.

Frank Day, Plant Engineer, Forest Park, for operating and maintaining a high-volume sampler.

Robert Hardy, Custodian, 5th District Police Station, for operating and maintaining a high-volume sampler.

Charles Bushman, William Brolaski, Robert Yauzty, and Walter Barry, Aeronautical Charts and Information Center, for their generous assistance in operating and maintaining high-volume and AISI samplers, cloth deterioration rack, and dustfall and lead peroxide candle equipment.

Charles Copley, Commissioner of Air Pollution Control, City of St. Louis, Jerome Molas, Industrial Hygiene Section, Anton Telford, Louis F. Klein and Richard Knapp, for operating and maintaining several high-volume stations throughout the City of St. Louis.

Malcolm Z. Brown, Air Pollution Sanitarian, St. Louis County Health Department, Charles K. Gillespie, Timothy Shea, Walter Horstman, and Leroy Vertrees for operating and maintaining several high-volume and AISI stations in the St. Louis County area.

James H. Carter, (deceased), Commissioner Air Pollution Control, City of St. Louis, for reading of AISI tapes.

L. F. Garber, Chief of Environmental Services, Missouri Division of Health, and J. S. Noel, for their general assistance.

Robert R. French, Sanitary Engineer, Illinois Department of Public Health, for his assistance.

Dr. Carl Rice, County Health Officer, Jefferson County, Missouri, and Oscar H. Fager, Public Health Engineer, for assistance in establishing sampling sites.

James P. Sperber, H. Neff Jenkins, Lowell F. Ring, Frank P. Partee, Dave L. Brooman, Norman Edmisten and S. W. Horstman, Project Engineers, Interstate Air Pollution Study, for direct and invaluable aid in the conduct of the Study.

John Wheeler, Technician, Interstate Air Pollution Study, for reading AISI tapes and general assistance in the conduct of the Study.

John J. Jamison[a] and George Hickman, Statistical Services Branch, Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio, for preparing the computer programs to process and analyze the data.

Francis L. Bunyard, Technical Assistance Branch, Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio, for assistance in processing the data.

William Jenkins, Inspector, Granite City, Illinois, for operating and maintaining high-volume, AISI, and oxidant samplers.

[a] Presently with International Business Machine Corporation.

William Smoot, (deceased) Inspector, East Side Health District, for operating and maintaining high-volume and AISI samplers.

Brother Joel, Alexian Brothers Hospital, for operating an oxidant sampler.

Dr. Eugene Tucker, St. Mary's Hospital, for operating an oxidant sampler.

Dr. French Hansel, for supplying daily pollen count data.

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III. AIR QUALITY MEASUREMENTS

INTRODUCTION

The purpose of Phase II operations of the Interstate Air Pollution Study was stated in the Phase II Project Agreement:

> The purpose of the project is to study in detail air pollution activity areas which were determined by Phase I of the Interstate Air Pollution Study to need further investigation; assist the two States and several local agencies to strengthen and coordinate their air pollution activities and control programs; develop the basis for, and assist with the establishment of an air resource management program; provide an operating framework within the project area for research and develonment work; and do research and technical investigation which will add to the body of existing knowledge on the nature, transport, and effects of air pollution.

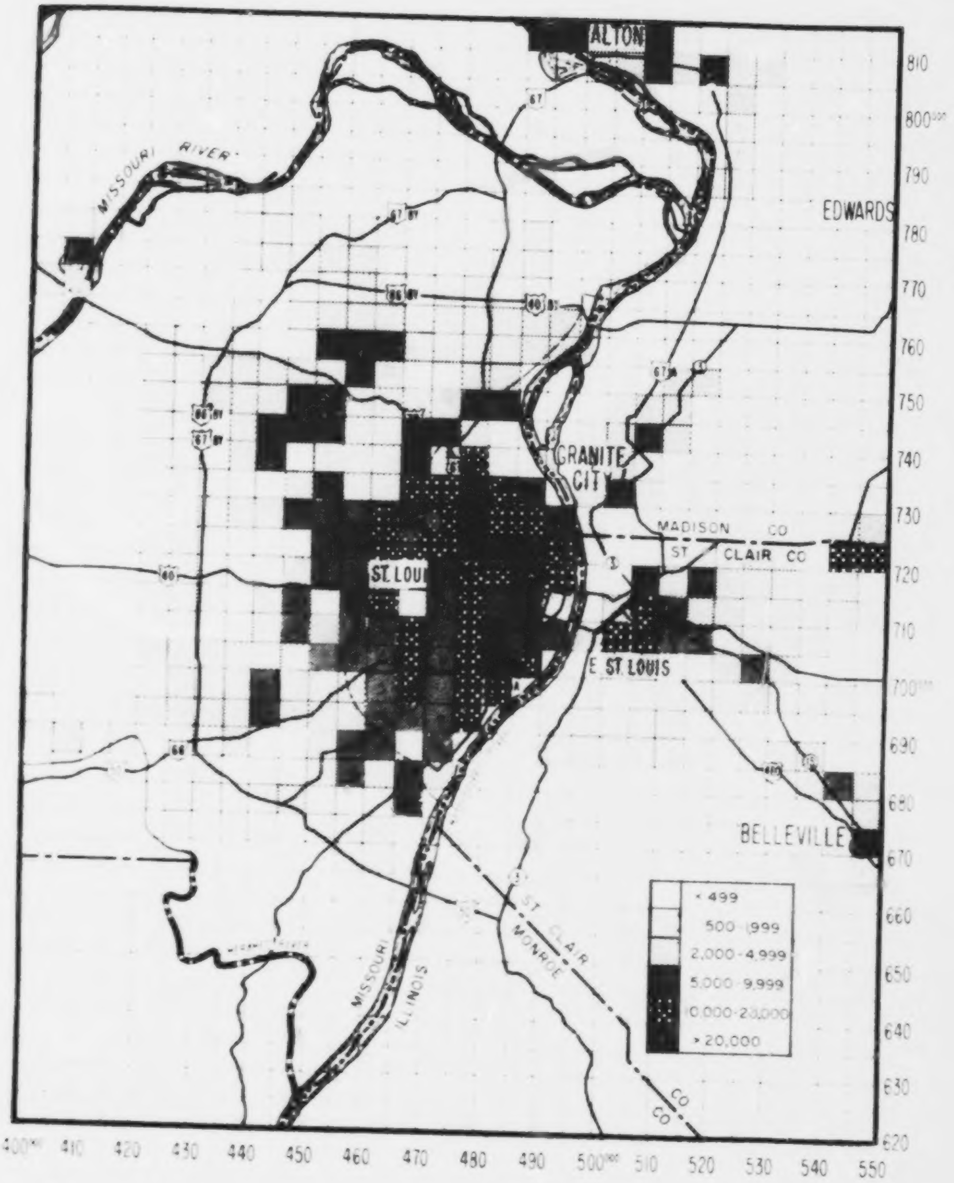
The development of an effective air resource management program begins with identification of the pollutants in the air, and determination of the quantity and origin of each type. The air quality measurement program was designed and operated to make these determinations in the Metropolitan St. Louis area. Once the physical aspects of the air pollution problem are defined, air-pollution-effect data and criteria as well as opinion surveys can be used to set the air quality goals. From this base, with use of the pollutant emission inventory, the air resource management emission control plan can be designed. At this stage the air quality measurement program is used to monitor the air quality to assure that the goals are attained.

In additon to its use in the air resource management program, this report provides a reasonably complete list of air quality data in a form that will assist research and program personnel in developing activities and attaining program objectives.

Figure 1, a population distribution map of the Study area, is provided to allow comparison between distribution of population, pollutants, and sampling measurement networks.

MEASUREMENT METHODS

Essentially two types of pollutants occur in the air, particulates and gases. The particulates are classified as suspended and settleable. The suspended particulates vary in size from less than 1 to approximately 100 microns;they remain suspended in the atmosphere for long periods of time. Because the settleable particulates are


ALTON
MISSOURI RIVER
EDWARDS
GRANITE CITY
MADISON CO
ST CLAIR CO
ST. LOUIS
E ST LOUIS
BELLEVILLE
ST CLAIR CO
MONROE CO
MISSOURI
ILLINOIS
< 499
500 1999
2,000-4,999
5,000-9,999
10,000-20,000
> 20,000
810
800
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550

Figure 1. Population from 1960 census by 5,000-foot grid squares.

much larger and heavier, they settle out of the air relatively close to their source. The gaseous pollutants, which are molecular in size, remain mixed in the atmosphere indefinitely since they have approximately the same density as the air itself.

Figures 2 and 3 are maps of the area showing the sampling site locations and delineating the equipment at each site. Table 1 gives a summary of all equipment and measurements made during the Study. Tables 2,3, and 4 give a classification of each site and the potential air pollution sources around them. Classifications are made using a modified Air Pollution Control Association (APCA) designation explained in Table 2. The classification describes three circular-segmented zones of activity around the station: 0 to ¼ mile, ¼ to ½ mile, and ½ to 1 mile. A single classification has not been assigned to a 360-degree circumference, but is given for 45-degree arcs centering in the north, in the northeast, and so on around the total circumference. This system records for eight directions from the samplers, the types of air pollutant source activity in operation. It helps with interpretation of data from each station.

Albums of black and white photographs were compiled to show the sampling sites and equipment and a view from the site in each principal direction. These albums were given to the Illinois Department of Public Health, the St. Louis Division of Air Pollution Control, and the St. Louis County Health Department.

Meteorological data are from the Weather Bureau Station at Lambert Field. Their relationship to data from other years and to the rest of the Study area is covered in Volume V,Meteorology and Topography.

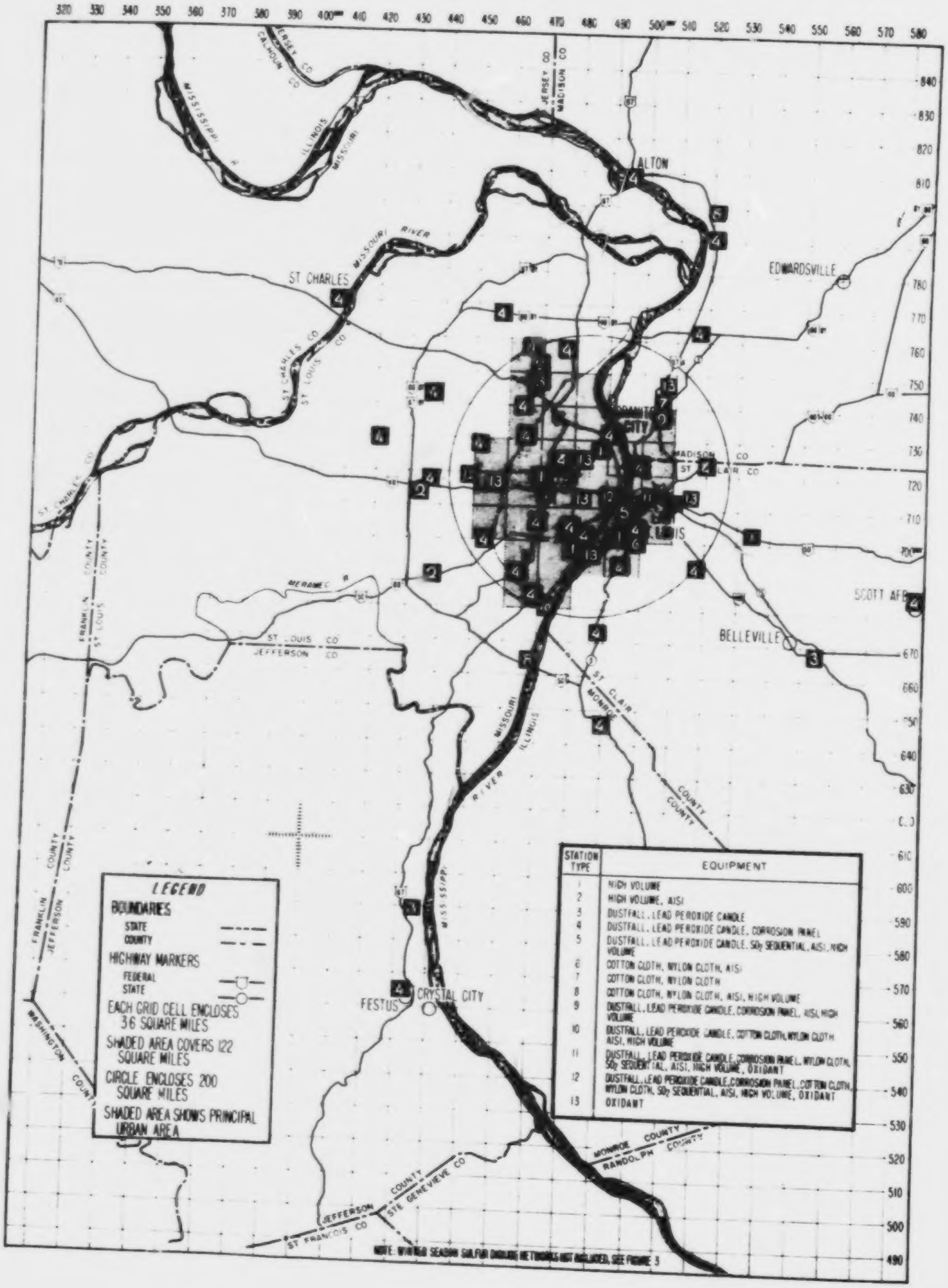
The stability classes were determined from meteorological data from Lambert Field by the Pasquill-Gifford-Turner stability classification criteria. These criteria are based on surface wind speed, daytime solar insolation, and nighttime cloud cover. They give the following classes: (1) extremely unstable, (2) unstable, (3) slightly unstable, (4) neutral, (5) slightly stable, (6) stable, and (7) extremely stable. For the purposes of this report, classes 6 and 7 are grouped with class 5. Thermal mixing, as influenced by solar radiation, is at its maximum for class 1 and at its minimum for class 5. The wind speed, however, is lowest at class 1, increases to its maximum at class 4, and decreases again at class 5.

The size of the air quality measurements program and the variety of measurements made are a credit to the numerous cooperating organizations and individuals.

PARTICULATE POLLUTANTS

Suspended Particulates

Suspended particulates were measured by both the high-volume air sampler and the AISI tape sampler. Suspended particulates are small particles that absorb, reflect, and scatter the sunlight and thus obscure visibility. When breathed, they


ALTON
EDWARDSVILLE
ST CHARLES
GRANITE CITY
ST LOUIS
BELLEVILLE
SCOTT AFB
FESTUS
CRYSTAL CITY
MISSISSIPPI R
ILLINOIS
MISSOURI RIVER
MERAMEC R
JERSEY CO
CALHOUN CO
MADISON CO
ST CLAIR CO
ST CHARLES CO
ST LOUIS CO
JEFFERSON CO
FRANKLIN COUNTY
WASHINGTON COUNTY
MONROE COUNTY
RANDOLPH COUNTY
STE GENEVIEVE CO
ST FRANCOIS CO
LEGEND
BOUNDARIES
STATE
COUNTY
HIGHWAY MARKERS
FEDERAL
STATE
EACH GRID CELL ENCLOSES 36 SQUARE MILES
SHADED AREA COVERS 122 SQUARE MILES
CIRCLE ENCLOSES 200 SQUARE MILES
SHADED AREA SHOWS PRINCIPAL URBAN AREA
NOTE: WINTER SEASON SULFUR DIOXIDE NETWORKS NOT INCLUDED, SEE FIGURE 3

STATION TYPE	EQUIPMENT
1	HIGH VOLUME
2	HIGH VOLUME, AISI
3	DUSTFALL, LEAD PEROXIDE CANDLE
4	DUSTFALL, LEAD PEROXIDE CANDLE, CORROSION PANEL
5	DUSTFALL, LEAD PEROXIDE CANDLE, SO_2 SEQUENTIAL, AISI, HIGH VOLUME
6	COTTON CLOTH, NYLON CLOTH, AISI
7	COTTON CLOTH, NYLON CLOTH
8	COTTON CLOTH, NYLON CLOTH, AISI, HIGH VOLUME
9	DUSTFALL, LEAD PEROXIDE CANDLE, CORROSION PANEL, AISI, HIGH VOLUME
10	DUSTFALL, LEAD PEROXIDE CANDLE, COTTON CLOTH, NYLON CLOTH AISI, HIGH VOLUME
11	DUSTFALL, LEAD PEROXIDE CANDLE, CORROSION PANEL, NYLON CLOTH, SO_2 SEQUENTIAL, AISI, HIGH VOLUME, OXIDANT
12	DUSTFALL, LEAD PEROXIDE CANDLE, CORROSION PANEL, COTTON CLOTH, NYLON CLOTH, SO_2 SEQUENTIAL, AISI, HIGH VOLUME, OXIDANT
13	OXIDANT

Figure 2. Study area aerometric network and grid system.

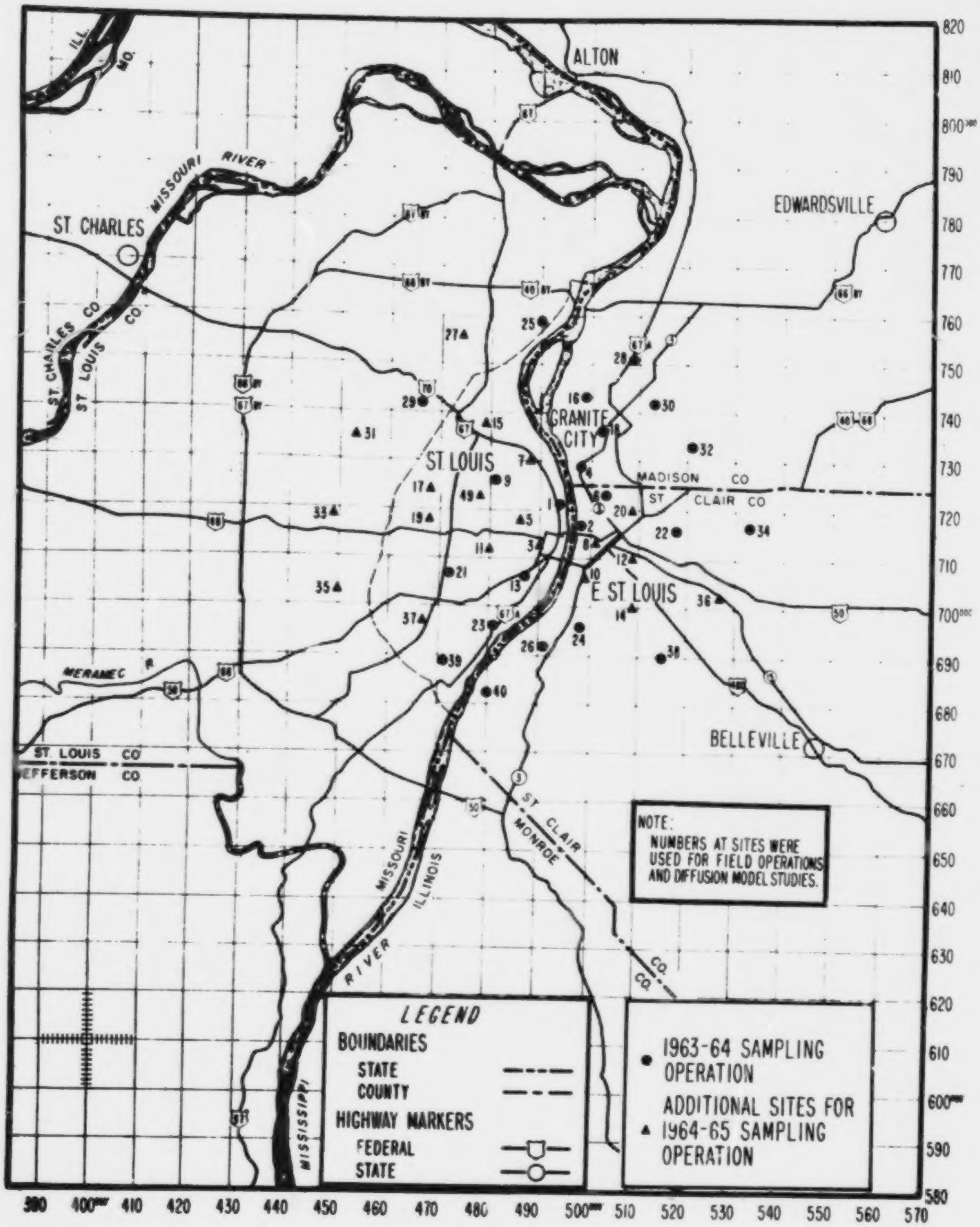

ALTON
EDWARDSVILLE
ST. CHARLES
MISSOURI RIVER
ST. CHARLES CO
ST. LOUIS CO
ILL.
MO.
ST. LOUIS
GRANITE CITY
MADISON CO
ST CLAIR CO
E. ST. LOUIS
BELLEVILLE
MERAMEC R
ST. LOUIS CO
JEFFERSON CO
ST CLAIR
MONROE CO
MISSOURI
ILLINOIS
RIVER
MISSISSIPPI
NOTE:
NUMBERS AT SITES WERE USED FOR FIELD OPERATIONS AND DIFFUSION MODEL STUDIES.
LEGEND
BOUNDARIES
STATE
COUNTY
HIGHWAY MARKERS
FEDERAL
STATE
● 1963-64 SAMPLING OPERATION
▲ ADDITIONAL SITES FOR 1964-65 SAMPLING OPERATION

Figure 3. Sulfur dioxide sampling network for winter seasons.

Table 1. SUMMARY OF ROUTINE AIR QUALITY MEASUREMENT PROGRAM

Measurement	Number of stations	Equipment	Frequency of measurement	Determination	Analytical method	Remarks
Dustfall	42	Plastic dustfall collectors - dry	1 30-day sample/ month	Weight of water soluble and insoluble	Gravimetric[25,26,27]	Equipment located on stands on roofs or other suitable supports.
Sulfation	42	Lead peroxide candle	1 30-day sample/ month	Sulfur trioxide determined as sulfate	Barium chloride method for sulfates, gravimetric and turbidimetric 28,29,7,30,31,32,33,34	Equipment located on stands on roofs or other suitable supports.
Suspended particulates	17	High-volume air sampler	1 24-hour sample/day	Total weight of particulate	Gravimetric[35, 9, 36]	Detailed analyses were performed on a small portion of samples.
Suspended particulates	12	AISI strip filter paper sampler	12 2-hour samples/day	Change in light transmission thru filter paper	Photometric[37, 38]	
Sulfur dioxide	40	Polyethylene tubes and glass impingers	1 24-hour sample/day	Sulfur dioxide	West and Gaeke[39,40,41,] 42,43,44,45	Used prefilters during 1963-64 study. Equipment located on utility poles.
Sulfur dioxide	13	Automatic sequential sampler with midget impingers	12 2-hour samples/day	Sulfur dioxide	West and Gaeke	
Oxidants	9	Midget impinger	3 10-minute samples/day	Total oxidants	Phenolphthalin[46,47,] 48,49,50	Samples were collected at 9:00 a.m., 12 N., and 3:00 p.m.
Hydrogen sulfide	2	AISI sampler with lead acetate impregnated paper	12 2-hour samples/day	Change in light transmission thru filter paper	Photometric[51,52]	
Aeroallergens	1	Rotoslide[53] and Durham[54,55]	1 24-hour sample/day	Pollen and molds	Counting with a microscope	Rotoslide sampler at site 490-713; Durham sampler at site 481-817.
Visibility	1	Human observer	One observation/ day, usually in morning		Visual observation	Observations were made in two directions, E and SW.
Atmospheric turbidity	1	Sun Photometer	One or two day during daylight hours	Atmospheric turbidity	Volz Type G Sun Photometer[56]	Measurement could not be made when sun was obscured.
Materials deterioration	36 8 7	Steel panels Nylon panels Cotton panels	2-4-8-16 months 1-12 months 1-12 months	Weight loss Degradation Degradation	Gravimetric[57] Visual observation Residual strength, pH, and fluidity[57]	

Table 2. CLASSIFICATION OF SAMPLING SITES WITH RESPECT TO DIRECTION[a]

Site coordinates	Direction								Station Type[b]	Remarks
	N	NE	E	SE	S	SW	W	NW		
407-770	BBG	BBB	BBF	BBE	BAG	BAG	BBG	BGG	4	Gravel operation 1 mile to the E; oil tank storage and industrial area E and SE.
421-729	GGG	GGG	AGA	AAG	AAG	AAG	AAG	EGG	4	Chemical plant about 2 miles N.
432-715	AAA	AAA	AAA	AAA	AAA	AAA	AAA	AAA	2	
433-565	AGG	BGG	BCC	BBG	BBG	BGG	BGG	BGG	4	
435-589	CGG	CGG	CGG	CGG	CGG	CGG	CGG	CGG	3	
435-717	AAA	AAA	AAA	AAA	AAA	AAA	AAA	AAA	4	
436-743	AAA	AAA	AAA	AAA	AAA	AAA	AAA	AAA	4	Chemical plant about 2 miles N.
438-689	CBA	CBB	CAA	CAA	CAA	CAA	CCC	CAA	2	
449-719	BBB	BBB	BBB	CCB	CCC	CAA	CAA	CAA	12	Hospital power plant 1/4 mile NW.
451-728	AAC	AAA	AAA	AAA	AAA	AAA	AAA	AAA	4	
453-701	BBC	BBF	BAB	BBF	BAG	BBD	BBD	BBA	4	
457-766	DAG	DAG	AAG	AAA	AAA	AAA	AGG	DAA	4	
463-691	CAB	GBB	GGA	AAA	AAA	CCC	GGA	GGG	4	Chemical plant 2 miles SE.
464-740	DAA	DAA	DAB	BBB	BBA	BGG	BGG	DCA	4	
465-731	DFB	DFB	DBB	DDB	DBB	DBF	DBF	DDD	4	
467-758	CAA	AAA	AAA	CAA	CAA	CAA	AAA	AAA	8	
468-665	GBB	GGG	GGG	GFG	GGG	GAG	GAA	GAB	4	Oil storage tank 1/2 mile NE; gravel operation 1-1/2 miles south of sampling site located on hospital building situated on inactive military post.
469-683	CGA	CCB	CFF	CFF	CFG	CBB	AAA	AFA	4	Foundries, chemical plants 1/2 - 1 mile E; gravel operation 1-1/2 miles S; gravel processing 1 mile E; coking operation and chemical plant 1/2 - 1 mile SE; foundries, grain processing, metal coating.
469-705	FCC	FBC	FDB	FCC	FCC	FCB	CCB	FCB	4	
469-749	CBG	CAA	CAA	CAA	CAA	CAA	CAA	CGG	3	
469-750	CBG	CAA	CAA	CAA	CAA	CAA	CAA	CGG	2	
470-718	GGB	GBB	CBB	CCB	GGF	GGF	GGG	GGG	1	Grain processing 1-1/2 miles SE; metal melting 2-1/2 SW.
471-714	GGG	GGC	CBB	CFF	CFF	CFF	CCC	GGG	4	Grain processing 1-1/2 miles E.
472-680	FFC	FFF	FGG	FGG	FFG	EEA	CAB	CAB	10	Heavy industrial area on west bank of river, coking, grain, foundries, chemical.
476-724	CBB	CBB	CCC	BBB	BBB	BBB	BBC	CCB	4	Grain processing 2 miles NE; grain processing 2 miles S.
477-758	AGG	AGG	AAA	AAA	AAA	AAA	AAA	AAA	4	
479-704	BBB	BBB	BCB	BBB	BBB	BBB	BBB	BGB	4	Cement plant 1-1/2 miles SE; grain processing 2 miles N; grain processing 2 miles SE; grain processing 1/2 mile SW.

Table 2. (Cont'd) CLASSIFICATION OF SAMPLING SITES WITH RESPECT TO DIRECTION[a]

Site coordinates	Direction								Station type[b]	Remarks
	N	NE	E	SE	S	SW	W	NW		
481-698	BBB	BBB	BCF	BCF	BFF	BBB	BBB	BBB	1	Grain processing 1-12 miles NE; incinerator 1/2 mile SE; grain processing 2 miles NW.
482-699	BBB	CFF	CFF	CFG	CFF	CCC	BBB	BBB	4	Grain processing 1-1/2 miles NE; grain processing 2 miles NW; incinerator 3/4 mile SE.
488-672	AAE	AGG	AGG	GGG	GGG	AAE	AEE	AEE	4	Gravel operation 1/2 mile E.
489-728	BCF	CFF	CFF	CCF	BBB	BBB	BBB	BBB	1	Grain processing, incineration NE. Power plant 1-1/2 mile E; chemical plant 1/2 mile SE.
490-646	AAG	AAG	AAG	AAG	AGG	AGG	AAG	AAA	4	Auto burn 2 miles NW.
490-713	DDD	DDD	DDD	DDF	DDC	DEB	DEE	DDC	12	Power plant 2 miles NE; chemical plant 2 miles S.
490-730	FEE	FEG	FFG	FFF	CCB	CBB	BBB	FFF	4	Grain processing and incineration 1/2 mile NE; chemical plant 1 mile SE; power plant 1-1/2 miles E.
494-703	FCF	FFF	FFF	FFE	EEE	GGG	GGF	GGF	1	Power plant 1/4 mile N; industrial area.
495-693	CAA	AAA	AAA	AAA	AAG	AAA	CAA	AAF	4	Open burning about 1 mile NW, 1 mile E; burning dump 1/4 mile SE; chemical plant 1 mile NW.
495-709	GGD	GFF	DFF	GGF	GGF	GFF	GFD	GDD	5	Industrial area 1 mile SE; industrial area 3/4 mile W; steel plant 1 mile E; auto burn 3/4 mile S.
495-809	BBA	BBB	DCC	EFF	DGG	DGG	CEG	BAA	4	
498-704	FFF	FFB	FEB	FFF	FFC	FEE	FEF	FEE	4	Heavily industrialized.
499-700	EFF	EFF	EFF	GEG	AAE	GGA	GEF	GFF	6	Heavily industrialized.
499-724	BEC	BGE	BEF	BFF	BFF	EEG	EGG	BEE	4	Burning dump 1-1/2 miles E; industrial area 1 mile SE.
501-713	DFF	DFF	DCB	DFF	DCE	DFF	DFF	DFF	11	Industrial area 1-1/2 miles N. and 1-1/2 miles S; power plant and industrial area 1-1/2 miles NE.
505-740	BEE	BBB	DDC	CFF	DFF	DFF	DFF	DFF	9, 7	Heavy industrial area SE, S. SW, W, and NW, including steel plant.
509-710	CCE	CEE	CDE	CBB	CBB	CCE	CDB	CCB	4	Burning dump 2 miles N; industrial area 2 miles SW and 2-1/2 miles NW.
517-692	AAA	AGG	AGG	AAG	AAG	AAA	AGG	AAA	4	Auto burn 2 miles N; burning dump 2 miles W.
517-762	GGG	GGG	GGG	GGG	GGG	GGG	GGG	GGG	4	
520-790	CFF	CFF	EFF	AAF	AAG	AAG	AGG	AGG	4	Oil refinery 1 mile N and 1 mile S; industrial area 1 mile E; burning dump 1/2 mile W.
520-798	CBA	CBA	FFA	FFF	FEE	FFF	CFG	CAA	8	Burning dump 1-1/2 miles N; burning dumps 2 miles SE; burning dump 1-1/2 miles S; power plant 2 miles W; surrounded by oil refinery.
521-725	AGG	AGG	AFG	AAG	AAF	AAF	AGG	AGG	4	Fertilizer plant 1 mile E; burning dump 2 miles SE; chemical plant 1 mile SE.

Table 2. (Cont'd) CLASSIFICATION OF SAMPLING SITES WITH RESPECT TO DIRECTION[a]

Site coordinates	Direction								Station type[b]	Remarks
	N	NE	E	SE	S	SW	W	NW		
534-702	AGG	AGG	AGG	AAG	AAA	AAA	AAA	AGG	1	
554-668	GGA	GAB	GGG	GGG	GGG	GGG	GGG	GGG	3	Auto burn 1/2 mile SE.
585-683	CCG	CCG	CCG	CCG	CCG	CCG	CCG	CCG	4	

[a] The following classification describes three radial segments of land use around the stations (0-1/4 mile, 1/4-1/2 mile, and 1/2-1 mile).

A - Residential, low density (less than 10 dwelling units per acre and non-rural).
B - Residential, high density (more than 10 dwelling units per acre).
C - Commercial, neighborhood shopping district.
D - Commercial, central business district.
E - Industrial, with low air pollution potential.
F - Industrial, with high air pollution potential.
G - Rural, 1 dwelling per 5 acres or larger area.

[b] Station types:

1 - High-volume.
2 - High-volume, AISI.
3 - Dustfall, lead peroxide candle.
4 - Dustfall, lead peroxide candle, corrosion panel.
5 - Dustfall, lead peroxide candle, SO_2 sequential, AISI, high-volume.

6 - Cotton cloth, nylon cloth, AISI.
7 - Cotton cloth, nylon cloth.
8 - Cotton cloth, nylon cloth, AISI, high-volume.
9 - Dustfall, lead peroxide candle, corrosion panel, AISI, high-volume.
10 - Dustfall, lead peroxide candle, cotton cloth, nylon cloth, AISI, high-volume.
11 - Dustfall, lead peroxide candle, corrosion panel, nylon cloth, SO_2 sequential, AISI, high-volume.

12 - Dustfall, lead peroxide candle, corrosion panel, cotton cloth, nylon cloth, SO_2 sequential, AISI, high-volume.

Table 3. CLASSIFICATION OF SULFUR DIOXIDE SAMPLING SITES WITH RESPECT TO DIRECTION

Site coordinates	Direction								Remarks
	N	NE	E	SE	S	SW	W	NW	
494-721	CEF	CEG	CGE	EFE	CEE	CDD	CDB	CBB	Chemical plant 1 - 2 miles N; two steam generating power plants, one N, one S, several industrial and commercial power plants S.
481-726	BBB	BBB	BBB	BBB	BBB	BBB	BBB	BBB	
487-706	BBB	BBE	BBF	BBF	BBF	BBB	BBB	BBB	Industrial power plants, warehousing, and manufacturing 1/2 - 1 mile E, SE, S.
472-707	BEF	GGB	GAB	GGB	GBF	GBF	BEE	BBF	Commercial, industrial NW, 1/3 mile; industrial 1-1/2 miles S.
481-696	BBB	BBB	BCF	BCF	BFF	BBB	BBB	BBB	Industrial 1 - 2 miles S; city incinerator E.
490-759	AGG	AGG	AGG	AAG	AAG	AAA	AAA	AAA	Cement plant 1-1/2 - 2 miles S.
466-742	AAA	AAA	AAA	AAA	AAA	AAA	AAA	AAA	
471-689	AGB	ABB	AGB	BBF	BCC	BAA	BBG	AAB	Chemical plant 1 - 2 miles W; cement plant S.
498-717	FFE	FFF	FFF	FFF	FFF	EGD	GGF	GGF	RR marshalling yards, power plants; packing houses and cattle yards.
498-729	BCC	CCC	BEE	BEE	BEE	BEG	EBG	BEE	Electric generating power plant 1 - 2 miles SW.
503-723	EFE	FFG	EGF	EEE	EEF	EFF	FFF	FFE	Burning dumps 1/4 mile NE, 1 - 2 miles E; fertilizer plant 1/2 mile E; meat processing 1 mile W.
499-743	GGG	GAA	BBF	BBF	BFF	GFF	GGG	GGG	Heavy industrial SE, S, SW 2 - 3 miles.
502-736	FFF	FFF	FFF	CCB	CBB	CEE	EEE	EEE	Steel foundry N; steel foundry and mill E, rail yards NNW.
518-716	AEF	ABF	ABB	BBB	BBB	BBB	BBB	BBE	Chemical plant NE, fertilizer plant 1 mile N.
491-692	AGF	AAF	AAG	AAG	AAA	GGG	GGG	GGG	
509-751	GGG	GGG	GAB	AGA	AGA	AGA	GGG	GGG	
513-742	BBB	BAG	BGG	AGG	BBF	BBF	BBB	BBB	Gas tanks, iron ore processing 1 - 2 miles SW.
533-717	GGG	GGG	GGG	GGG	GGG	GGG	GGG	GGG	
515-690	AAA	AAA	AAA	AAA	AAA	AAA	AAA	AAA	
480-682	AGG	AGG	AGG	AGG	AGG	AGG	AGG	AGG	

Table 4. CLASSIFICATION OF OXIDANT NETWORK SAMPLING SITES WITH RESPECT TO DIRECTION

Site coordinates	Direction								Remarks
	N	NE	E	SE	S	SW	W	NW	
449-719	BBB	BBB	BBB	CCB	CCC	CAA	CAA	CAA	Hospital power plant 1/4 mile NW.
458-755	BBB	BBB	BBB	BBB	BBA	BBB	BBB	BBB	
482-697	CBB	CCF	CFG	CFG	CFG	CCB	BBB	BBB	Grain processing 1-1/2 miles NE and 2 miles NW; incinerator 3/4 mile SE.
485-714	CCB	CCD	CDD	CEE	CEB	CEB	CFF	CCC	Industrial area 1 - 2 miles W.
490-713	DDD	DDD	DDD	DDF	DDC	DEB	DEF	DDC	
501-713	DFF	DFF	DCB	DFF	DCE	DFF	DFF	DFF	Industrial area 1-1/2 miles E; 1-1/2 miles S; power plant and industrial area 1-1/2 miles NE.
507-741	BEE	BBB	DDC	CFF	DFF	DFF	DFF	DFF	Heavy industrial area SE, S, SW, W and NW, including steel mill.
509-710	CCE	CEE	CBE	CBB	CBB	CCE	CDB	CCB	

penetrate deeply into the lungs. They also cause economic loss because of their soiling and corrosive properties.

High-volume Air Sampler - Suspended particulate samples were collected with high-volume air samplers[9,35,36] (Figure 4), which operate somewhat like a vacuum cleaner. With this method, glass fiber filters are weighed and mounted on the samplers. Air is normally drawn through the filter at a rate of about 50 cubic feet per minute. During the Study, transformers were placed on the samplers to increase motor life and decrease brush wear. These units decreased the average flow to about 35 to 40 cubic feet per minute. After 24 hours of sampling (from 2:00 p.m. to

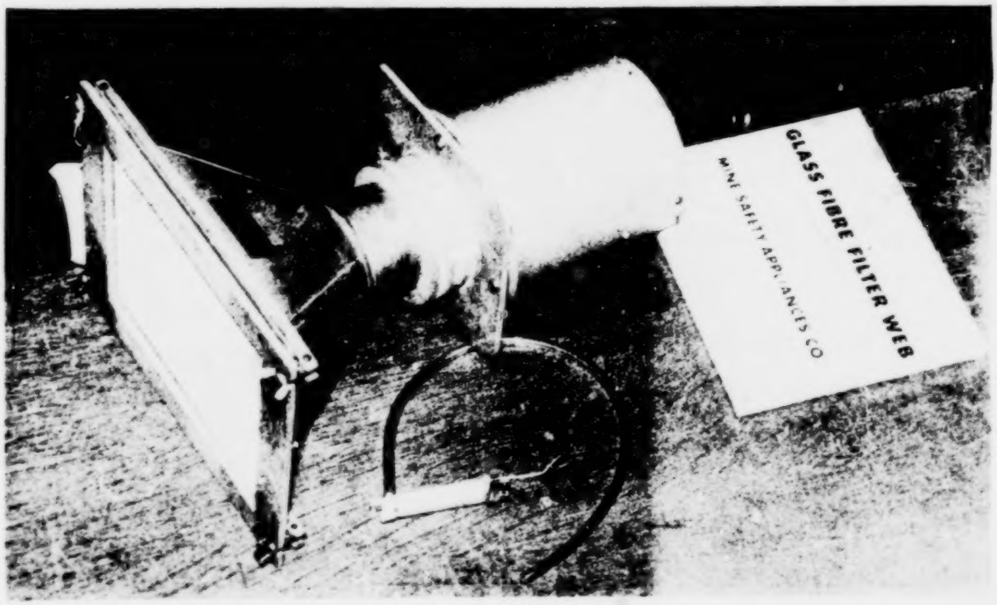


Figure 4. High-volume air sampler.

2:00 p.m.), the filters were reweighed to determine the increase in weight due to the particulate matter that was removed from the sampled air by the filter. The results are expressed as micrograms of particulates per cubic meter of air sampled.

In addition to the total weight of the sample, metals, organic content, and certain organic chemicals were measured on selected samples by the U. S. Public Health Service Laboratory of Engineering and Physical Sciences. The filters were saved for possible further analysis.

The particles consist of dust, smoke, and fumes; they come from incomplete combustion of fuels and wastes, gravel handling and crushing operations, metallurgical processes, chemical processes, grain handling operations, earth moving operations, and many other similar processes.

The sampling schedule for the high-volume sampler network was a combination of continuous weekday and random sampling. At the beginning of the Study a random sampling schedule of 100 days was established for the period July 1, 1963, through June 30, 1964. In addition to the 100 days, 75 percent of September and all of October were to be sampled for a total of 141 sampling days. This schedule was altered during the Study so that continuous weekday sampling was performed from September 1963 through March 1964 and the random schedule was followed during the other 5 months.

AISI Automatic Tape Sampler - The AISI sampler[37,38] (Figure 5) also collects suspended particulates and operates by drawing air through a small area on a strip of Whatman No. 4 filter paper at a rate of approximately 0.25 cubic foot per minute. After 2 hours of operation, the sampler automatically shifts the filter paper to a new position and continues operation. The quantity of material collected is

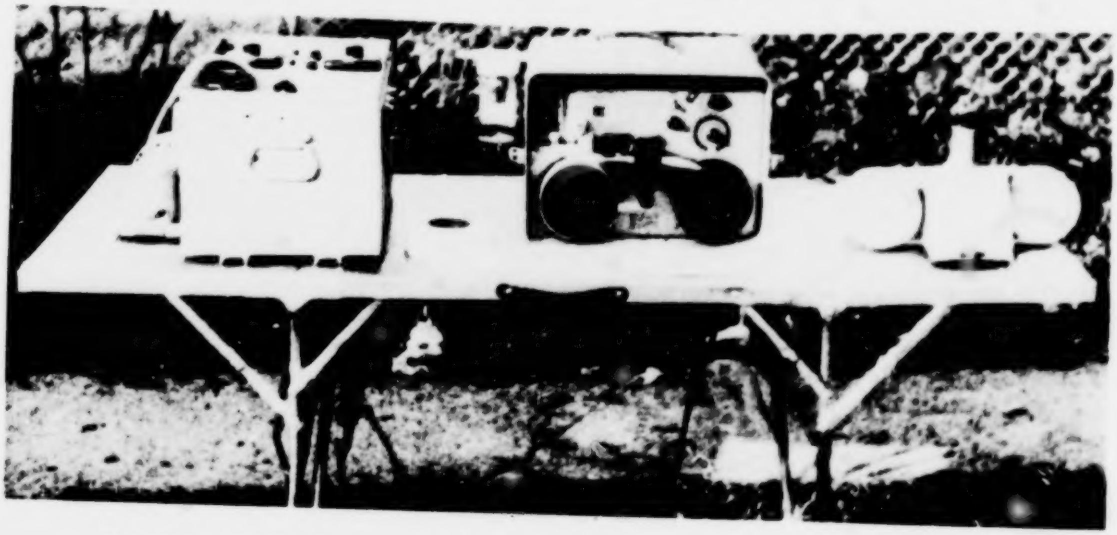


Figure 5. Sequential sampler, AISI tape sampler, and AISI tape reader.

determined by the difference in the amounts of light that pass through the spot and the unexposed filter. The results, expressed as Cohs (coefficient of haze) per 1,000 lineal feet, describe the soiling properties of the air.

Settled Particulate

Settled particulate, or dustfall,[25,26,27] measurements determine the amounts of heavy airborne particles, i.e., those that settle from the air readily. Settled particulate measurements vary greatly both between and within urban areas since they are affected by many variables such as commercial and industrial activity, construction, fuel use patterns, meteorology, traffic patterns, and solid-waste disposal practices.

These large particles are usually trapped or filtered out in the upper respiratory tract and do not enter the lungs. They do, however, settle and cause horizontal surfaces to become dirty.

Dustfall was measured by exposing 5-quart, 8.25-inch-high, 7.5-inch-diameter mouth, plastic jars in suitable stands (Figure 6) on a roof or other support for 1-month exposure periods. The jars were covered after the exposure period and

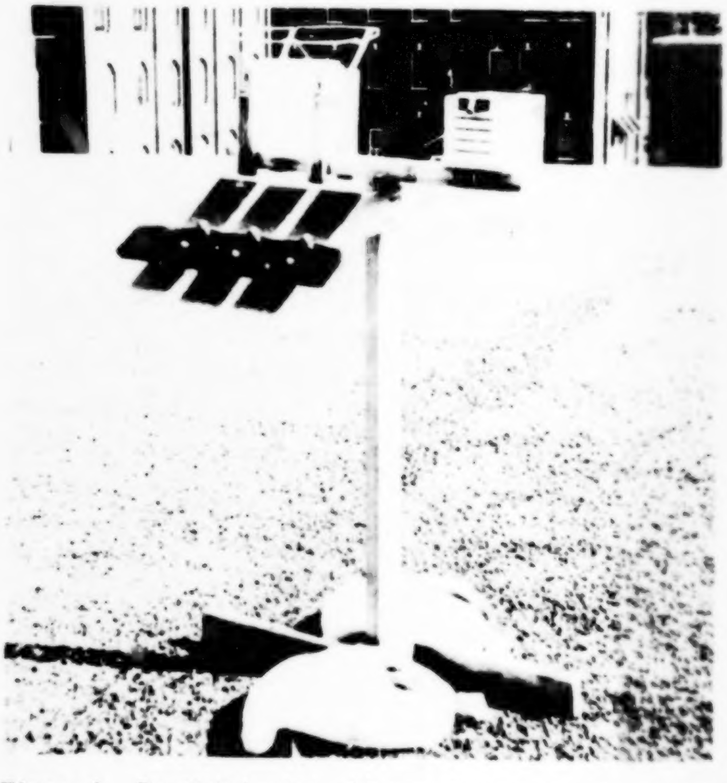


Figure 6. Dustfall bucket with metal corrosion panels and sulfation candle.

returned to the laboratory, where the water-soluble and -insoluble portions were determined. The results are expressed in tons per square mile per month.

A common practice for dustfall sampling is to maintain a liquid level in the jars to prevent the particles from being blown out. In this Study the jars were set out dry. A study was performed at the Taft Sanitary Engineering Center in Cincinnati, Ohio, to determine whether there was a significant difference in collection with the two methods. This study, although not conclusive, showed that up to 50 percent of the solids collected may be reentrained into the atmosphere when the bottom of the jar is dry. Being exposed to the elements, a dry jar naturally becomes a wet jar when it rains. The amount of dust retained depends then on how much and how often it rains, and the evaporation that takes place between rains. During the study unusually dry weather was experienced at times; therefore, the dustfall data recorded were undoubtedly conservative (low).

The Cincinnati study also showed that dustfall jars 10.75 inches deep were not more efficient than the 8.25-inch-deep jars used in this Study. The results of this Study are given in the Interstate Air Pollution Study Memorandum of Information and Instruction No. 6a,* "Collection and Analytical Procedure for Settled Particulate."

GASEOUS POLLUTANTS

The gaseous pollutants measured in this Study were sulfur dioxide, total oxidants, and hydrogen sulfide. In addition to these measurements, the CAMP (Continuous Air Monitoring Program) station, which began operating March 1, 1964, sampled the air for carbon monoxide, nitrogen dioxide, nitrogen oxide, total oxidants, sulfur dioxide, and total hydrocarbons.

Sulfation (Lead Peroxide Candle Method)

Basically, the sampler (Figures 6 and 7) consists of a cylinder around which is wrapped a gauze coated with a paste containing lead dioxide. Sulfur dioxide gas and certain other sulfur compounds react with the lead dioxide to give lead sulfate. The samplers are exposed for a period of 1 month and then analyzed for sulfate. The results are expressed as milligrams of sulfur trioxide per 100 square centimeters per day.[31]

The reactivity of lead peroxide varies from one batch to another; therefore, enough lead peroxide was purchased to last the entire Study. So that the results of this Study could be compared with those data obtained from other areas, the

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* The Memorandums of Information and Instruction cited throughout this report were directed to the project staff and constitute a detailed record of the procedures employed.

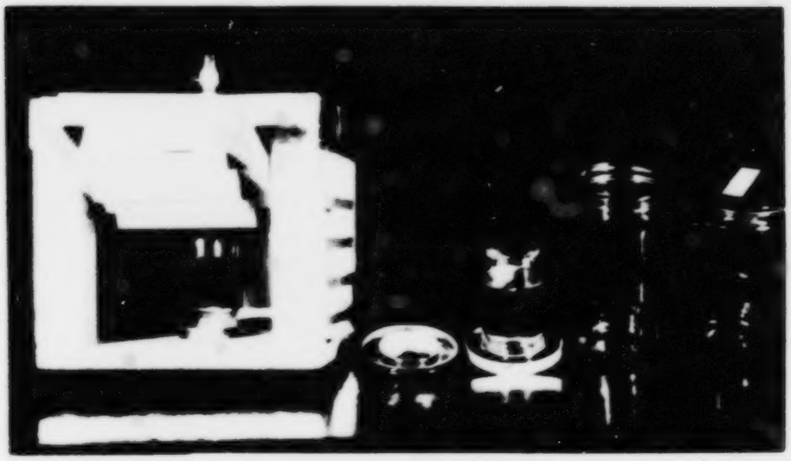

Figure 7. Lead peroxide candle and shelter.

batch of lead peroxide used was standardized against a standard lead peroxide purchased from Research Appliance Company which in turn was standardized to the British standard Batch Type A. The details of this standardization are given in the Interstate Air Pollution Study Memorandum of Information and Instruction No. 13, "Standardization of the Lead Peroxide Candles." During the Study the Illinois Department of Public Health Division of Laboratories successfully developed and tested a turbidimetric method for the determination of sulfates in lead peroxide candles. This method is reported in Memorandum of Information and Instruction 6C, dated March 1965.

Sulfur oxides, which include sulfur dioxide, in the ambient air are of interest because of (1) their harmful effects on the health of humans and animals, (2) their demonstrated harmful effects on vegetation, and (3) their economic effects as evidenced by materials deterioration and metal corrosion.

Sulfur dioxide in the air is thought to undergo changes in the following sequence: from sulfur dioxide, to sulfur trioxide, to sulfuric acid, and finally to sulfate. Although these changes are not fully understood, the intermediate product, sulfuric acid, is known to be a greater hazard to health than the sulfur dioxide from which it comes. Sulfuric acid, because of its hygroscopic nature, occurs in the air in small droplets, which, among other effects, reduce visibility.

Sulfur Dioxide (West-Gaeke)

The West-Gaeke method for measuring sulfur dioxide uses tetrachloromercurate (TCM) in a collecting solution.[39] The air is bubbled through the solution, which collects the sulfur dioxide in chemical combination. When certain dyes are added to the solution, the color changes. The intensity of the color change is measured by a spectrophotometer and related to the sulfur dioxide concentration. The results are expressed as parts per million by volume (ppm).

Two types of samplers were used during the Study. The automatic sequential sampler (Figure 8) collects twelve 2-hour samples over a 24-hour period, and the 24-hour sampler (Figure 9) collects one sample over a 24-hour period.

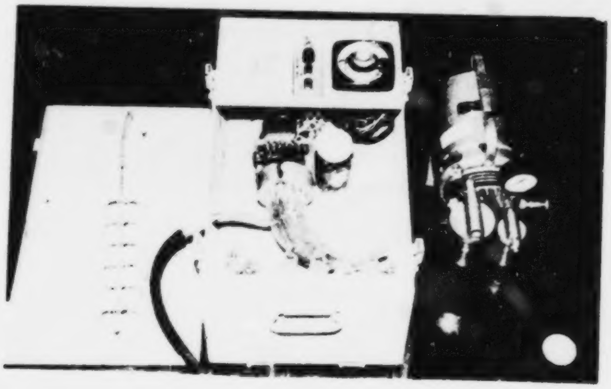

Figure 8. Two-hour sequential sampler.

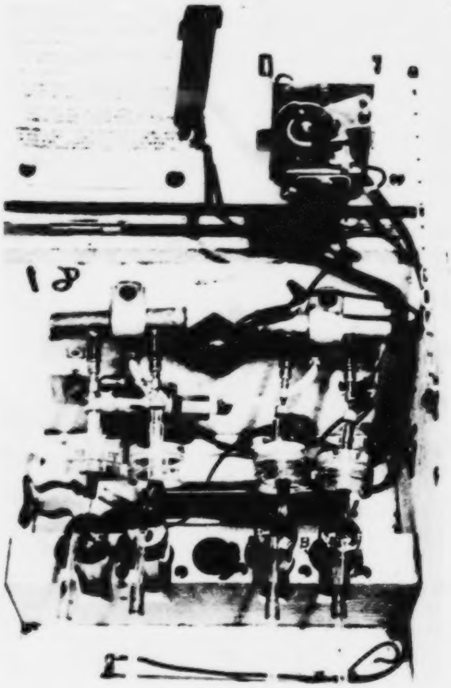

Figure 9. Twenty-four-hour composite gas sampler.

Total Oxidants (Phenolphthalin)

The total oxidants were measured by bubbling air through a solution of phenolphthalin. In this procedure, the oxidants change the phenolphthalin to phenolphthalein and the color of the solution changes.[46] The color change is measured by a spectrophotometer, and the results are expressed in ppm.

The components of the oxidant sampling train (Figure 10) were arranged in the following order: 18 inches of Teflon tubing, a bubbler containing the phenolphthalin solution, a trap to collect any entrained solution, a rotometer, a valve to control airflow, and a pump. A timer was installed to stop the pump automatically after 10 minutes of operation.

Total oxidants are important because they indicate the presence of photochemical reaction products, which cause eye irritation, damage to vegetation and rubber, and reduced visibility. The oxidants (ozone and others) result from photochemical reactions involving nitrogen oxides and hydrocarbons in the presence of sunlight. High concentrations of true photochemical oxidants generally occur on days with low wind speeds, clear skies, and strong sunlight.

MATERIALS DETERIORATION

The relationship of air pollutants to the deterioration of materials was studied by exposing cotton cloth, nylon cloth, and steel panels. This study was made not only to obtain information concerning the Study area but also to develop methodology for determining economic damage due to air pollution. The cloth deterioration study was unique in that it was the first attempt to relate air pollution to deterioration of cloth.

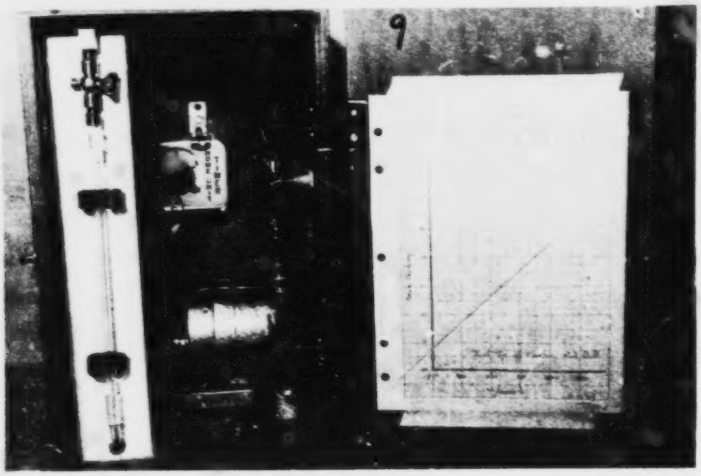

Figure 10. Oxidant sampler.

The steel panels (Figure 6) were 4 by 6 inches by 1/16 inch thick. The amount of corrosion was found by determining the loss in panel weight after removal of corrosion products. Eight panels were exposed at each of 35 sites. The exposure periods were 2, 4, 8, and 16 months. At the end of each period, two panels were removed from each site and analyzed. These panels are referred to as top and bottom because of their arrangement.

Seven sites were equipped with cotton panels and eight with nylon panels. Two weights of woven cotton cloth were used, a light cotton print and a 10.10-ounce army duck. Initially 12 panels were set out at each site, and one panel was removed each month for a period of 1 year. Each panel was analyzed for residual strength, pH, fluidity (a chemical-physical measure of degradation), and visual appearance. Figure 11 is a photograph of a cotton-exposure rack.

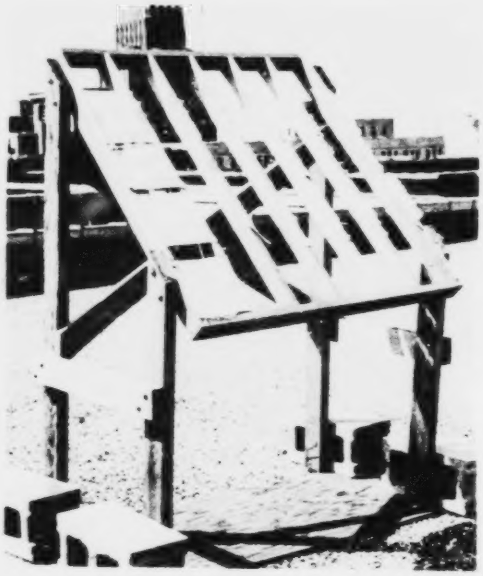

Figure 11. Cotton exposure rack.

The nylon panels were exposed 1 year also, but were not removed from the sites. A monthly visual observation was made to note any physical degradation of the panels. Since nylon is very sensitive to acids, the panels were examined to determine whether any small perforations developed. No physical or chemical tests were performed on these panels.

A short-term corrosion study was conducted from December 1, 1964, through February 28, 1965, as part of the 40-station sulfur dioxide sampling network. The methodology for this network was the same as that used in the earlier study.

VISIBILITY

When relative humidity is below 70 percent, decrease in visibility is due primarily to particulate matter in the air. An adverse condition for airport operation exists when visibility is less than 3 miles. Visibility observations were taken at the Project Field Office in downtown St. Louis, coordinates 493-713. Observations were usually made in the morning in two directions, southwest and east. At the same time, observations were taken with the Volz Sun Photometer, an instrument being developed to measure atmospheric turbidity directly. This method offers considerable promise as a new and economical method of measuring air quality.[70]

ATMOSPHERIC TURBILITY

Atmospheric turbidity,[56] as the name implies, refers to materials in the air that reduce its light-transmitting capability. For the most part these are small air pollutant particles. The effect of water vapor is excluded by selection of 0.5-micron-wavelength monochromatic light with a filter.

The Sun Photometer (Figure 12), which measures turbidity, consists of a small wooden box containing a filter, photoelectric cell, microammeter, and level. It is sensitive to 0.5-micron-wavelength monochromatic light. Attenuation of this light, after correction for the optical air mass, is a measure of turbidity between the sun and the photometer. Most of the turbidity is within a few hundred feet of the ground. Values range from 0.02 in very clean air to 0.60 in dirty air.

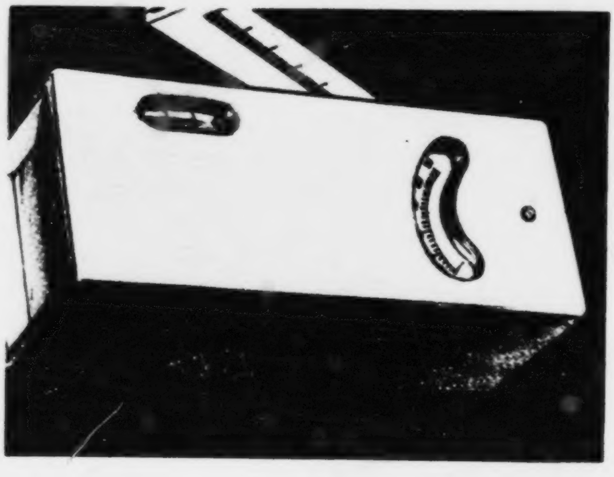

Figure 12. Sun photometer.

AEROALLERGENS

Pollen grains are one of the many aeroallergens that come from natural sources. Pollen grains, a primary cause of hay fever, come from weeds, grasses, trees, and other vegetation. Since pollens arise from vegetation, they are seasonal in character.

Pollen data were collected by exposing adhesive-coated microscope slides[54] at site 481-718. Collection was done by an allergist who makes daily counts during the pollen season. In making his count, he follows, in slightly modified form, the American Academy of Allergy gravity method, in which slides are exposed in a horizontal position in a shelter for 24 hours; the pollens are deposited on the slide by gravity and impingement from wind currents. The American Academy of Allergy counts the number of ragweed pollen grains per square centimeter by making a little over four crossings of a 22- by 22-millimeter (mm) cover slip using a 1-mm field. This number is converted into grains per cubic yard by multiplying by 3.6. The local allergist counts the number of pollen grains per 3.6 square centimeters by making eight crossings on a 22- by 22-mm cover slip using a 2-mm field. This number is equivalent to the grains per cubic yard and does not require a conversion factor as does the Academy's reading.

HYDROGEN SULFIDE

Hydrogen sulfide comes from the manufacture of coke, distillation of tar, petroleum and natural gas refining, kraft process pulp mill operations, other chemical processes, and anaerobic decomposition of putrescible matter. It has a very obnoxious odor and can be detected in concentrations as low as 13 ppb.[4] At very low concentrations it tarnishes silver and copper and blackens lead-base paints.

Two hydrogen sulfide sampling stations were operated during this study. They were situated at site coordinates 505-740 and 510-742, where they operated during the fall of 1964. The samplers were AISI units equipped with lead-acetate-impregnated paper to sample for hydrogen sulfide.[51] Twelve 2-hour samples were collected per day.

CAMP STATION

A Public Health Service Continuous Air Monitoring Program (CAMP)[71] station was installed in St. Louis in January 1964. The station, southwest of City Hall on the northwest corner of 12th and Clark Streets (coordinates 490-713) began operation in March 1964.

The station was equipped with six automatic instruments that sampled the atmosphere continuously to measure carbon monoxide, sulfur dioxide, nitric oxide, nitrogen dioxide, total oxidants, and total hydrocarbons. The basic instruments consist of a gas train, detector, flow-measuring equipment, and a pump. They are equipped with a strip chart recorder, which gives a continuous record of pollutant levels, and an analog-to-digital punch tape recorder, which contains 16-channel paper tape.

Carbon monoxide is determined by an infrared analyzer. Nitrogen dioxide is determined by colorimetry in which Griess - Saltzman reagent is used. The nitrogen oxide present is converted to nitrogen dioxide. The total nitrogen dioxide is compared with that previously measured, and the difference between the two determinations is attributed to the nitrogen oxide. Total hydrocarbons are measured by a hydrogen flame ionization analyzer, and sulfur dioxide is determined by electrical conductivity. Oxidants are determined colorimetrically with potassium iodide as the reagent.

Every 5 minutes the punch tape recorder punches a number in binary decimal code on the strip chart. The 16-channel tape data are automatically placed on 80-column punch cards, which, in turn, are processed by a computer to provide statistical summaries of each pollutant.

DISCUSSION OF RESULTS

GENERAL

Over 50,000 pieces of air quality measurement and meteorological data were processed during this Study. A summary of the kinds of measurements made is given in Table 1. Table 2 gives a description of the area around the sampling sites, and Figure 2 shows the location and types of equipment at each site. The details of the design of the aerometric network are given in the Interstate Air Pollution Study Memorandum of Information and Instruction No. 12, "Design of Air Quality Measuring Program."

A statistical evaluation is made of data from each type of air quality measurement. The arithmetic and geometric means and their standard deviation are determined for the year, each month, and each season. Spring is considered to be March, April, and May; summer is June, July, and August; fall is September, October, and November; and winter is December, January, and February.

In general the sampling day was the period from 2:00 p.m. of one day to 2:00 p.m. of the following day. The sampling day is referenced to the starting day rather than the ending day. Except for a few instances where operation records were not clear, all data refer to central standard time.

In this report data are reported in the text to agree with tabulated data direct from computer printouts. This arrangement facilitates use and checking of both. It does, however, give the appearance of greater numerical significance than is warranted or intended. Dustfall and suspended particulates should be considered valid to the nearest whole number, and Coh values, to the nearest tenth. Other pollutant measurements should be interpreted on the basis of known limitations of the measurement methods.

The results from the high-volume air samplers, the AISI samplers, and sulfur dioxide samplers were related to wind direction, which gave a graphical representation of wind directions and a group of specific air quality measurements taken at a fixed site. This method of data presentation is known as a pollution rose. A detailed procedure for preparing pollution roses is presented in Memorandum of Information and Instruction No. 18, "Standard Pollution Roses."

DUSTFALL

Dustfall measurements were made at 42 sites. The results are reported as total dustfall (soluble and insoluble) and are given in Tables 5 through 10. As in most urban areas, results varied, as is shown by the range of values from 3 to 176 tons per square mile per month during the measurement period from March 1963 to February 1964. The arithmetic mean for all stations during this period was 22.99 tons per square mile per month, and the geometric mean was 18.42 tons per square mile per month.

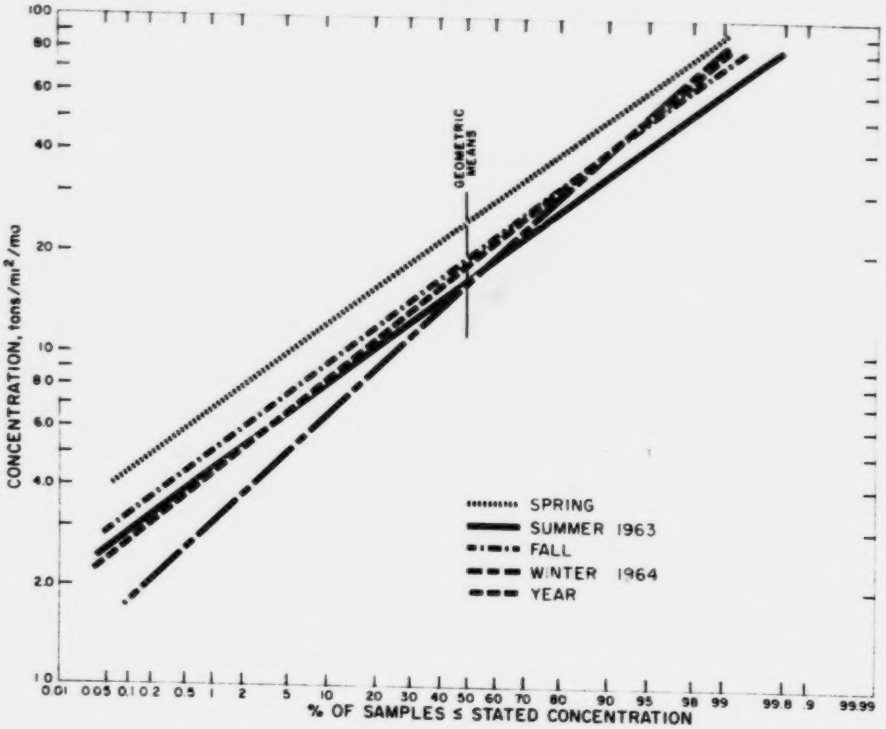

Figure 13. Dustfall frequency distribution, all sites.

Table 5. DUSTFALL, MARCH, APRIL, MAY 1963

(tons/mi^2/mo)

Site coordinates	Minimum	Maximum	N[a]	Arithmetic Mean	Arithmetic Standard Deviation	Geometric Mean	Geometric Standard Deviation
407-770	16	26	3	22.33	5.50	21.82	1.30
421-729	18	58	3	33.66	21.36	29.66	1.82
433-565	13	23	3	17.33	5.13	16.84	1.33
435-589	10	21	3	15.33	5.50	14.65	1.44
435-717	13	22	3	17.33	4.50	16.94	1.30
436-743	12	20	3	15.33	4.16	14.97	1.29
449-719	16	16	1				
451-728	15	26	3	22.33	6.35	21.64	1.37
453-701	18	19	2	18.50	0.70	18.49	1.03
457-766	15	23	3	20.00	4.35	19.65	1.26
463-691	16	26	3	20.66	5.03	20.26	1.27
464-740	18	29	3	24.33	5.68	23.85	1.28
465-731	20	40	3	30.66	10.06	29.47	1.42
467-758	17	27	3	22.00	5.00	21.61	1.26
469-683	25	35	3	31.00	5.29	30.67	1.19
469-705	23	28	2	25.50	3.53	25.37	1.14
469-749	17	26	3	20.33	4.93	19.96	1.25
471-714	21	37	3	31.66	9.23	30.63	1.38
472-680	94	123	2	108.50	20.50	107.52	1.20
476-724	17	29	3	21.66	6.42	21.07	1.32
477-758	21	30	3	27.00	5.19	26.63	1.22
479-704	13	21	3	16.66	4.04	16.34	1.27
482-699	17	30	3	23.00	6.55	22.38	1.32
488-672	15	33	3	23.33	9.07	22.16	1.48
490-646	11	25	3	16.00	7.81	14.88	1.56
490-713	13	13	1				
490-730	34	55	3	44.33	10.50	43.49	1.27
495-693	21	28	3	23.33	4.04	23.11	1.18
495-809	16	33	3	23.00	8.88	21.93	1.44
498-704	94	176	3	132.00	41.32	127.74	1.36
499-724	64	90	3	73.66	14.22	72.80	1.20
501-713	36	36	1				
505-741	49	83	3	69.66	18.14	67.90	1.32
509-710	18	26	3	22.33	4.04	22.07	1.20
517-692	15	32	3	22.00	8.88	20.89	1.47
517-762	13	20	3	16.33	3.51	16.08	1.24
520-790	21	31	3	25.33	5.13	24.99	1.21
521-725	21	24	3	23.00	1.73	22.95	1.08
554-668	10	17	3	12.66	3.73	12.32	1.32
585-683	9	17	3	12.33	4.16	11.89	1.38
All	9	176	115	29.51	25.26	24.20	1.75

[a] N = number of samples.

Of the 42 sites, only two had maximum values of less than 20 tons per square mile per month. Ten sites had values of over 50 tons per square mile per month, and two had values of over 120 tons per square mile per month. The

Table 6. DUSTFALL, JUNE, JULY, AUGUST 1963

(tons/mi^2/mo)

Site coordinates	Minimum	Maximum	N[a]	Arithmetic		Geometric	
				Mean	Standard Deviation	Mean	Standard Deviation
407-740			0				
421-729	14	19	3	16.00	2.64	15.86	1.17
433-565	6	9	3	7.33	1.52	7.23	1.22
435-589	9	11	3	10.00	0.99	9.96	1.10
435-717	7	12	3	9.66	2.51	9.43	1.31
436-743	9	12	3	10.00	1.73	9.90	1.18
449-719	11	12	3	11.66	0.57	11.65	1.05
451-728	10	18	3	13.66	4.04	13.27	1.34
453-701	7	9	3	8.00	0.99	7.95	1.13
457-766	8	53	3	23.66	25.42	16.18	2.81
463-691	12	18	3	15.66	3.21	15.42	1.24
464-740	12	14	3	12.66	1.15	12.63	1.09
465-731	15	20	3	16.66	2.88	16.50	1.18
467-758	8	20	3	12.66	6.42	11.69	1.61
469-683	17	30	3	24.66	6.80	23.96	1.35
469-705	21	23	3	22.33	1.15	22.31	1.05
469-749	16	20	3	18.00	1.99	17.92	1.11
471-714	14	22	3	17.66	4.04	17.36	1.25
472-680	45	65	3	56.33	10.26	55.67	1.20
476-724	12	12	3	12.00	0.00	11.99	1.00
477-758	17	21	3	19.00	1.99	18.92	1.11
479-704	10	12	3	11.33	1.15	11.29	1.11
482-699	17	18	3	17.66	0.57	17.66	1.03
488-672	13	13	3	13.00	0.00	12.99	1.00
490-646	9	15	3	11.33	3.21	11.05	1.30
490-713	12	21	3	16.33	4.50	15.91	1.32
490-730	17	42	3	29.33	12.50	27.45	1.57
495-693	16	18	3	16.66	1.15	16.64	1.07
495-809	11	18	3	14.00	3.60	13.70	1.28
498-704	83	105	3	95.00	11.13	94.55	1.12
499-724	44	54	3	50.00	5.29	49.80	1.11
501-713	30	33	3	31.33	1.52	31.30	1.04
505-741	32	35	3	33.33	1.52	33.31	1.04
509-710	15	33	3	22.33	9.45	21.10	1.49
517-692	15	23	3	17.66	4.61	17.29	1.27
517-762	12	18	3	15.00	2.99	14.79	1.22
520-790	22	26	3	24.00	1.99	23.94	1.08
521-725	16	16	3	16.00	0.00	15.99	1.00
554-668	10	11	3	10.33	0.57	10.32	1.05
585-683	7	10	3	8.33	1.52	8.24	1.19
All	6	105	120	20.08	16.48	16.52	1.76

[a] N = number of samples.

frequency distribution of all sites (Figure 13) indicates that values equal to or greater than 42 tons per square mile per month occurred 10 percent of the time during the year.

Table 7. DUSTFALL, FALL - SEPTEMBER, OCTOBER, NOVEMBER 1963

(tons/mi^2/mo)

Site coordinates	Minimum	Maximum	N[a]	Arithmetic		Geometric	
				Mean	Standard Deviation	Mean	Standard Deviation
407-770	11	19	3	14.00	4.35	13.58	1.34
421-729	14	16	3	15.33	1.15	15.30	1.08
433-565	7	10	3	8.33	1.52	8.24	1.19
435-589	9	15	3	11.00	3.46	10.67	1.34
435-717	10	15	3	12.33	2.51	12.16	1.22
436-743	12	16	3	14.00	1.99	13.90	1.15
449-719	11	24	3	16.33	6.80	15.46	1.49
451-728	11	16	3	13.00	2.64	12.83	1.21
453-701	10	18	3	12.66	4.61	12.16	1.40
457-766	11	17	3	13.00	3.46	12.71	1.28
463-691	14	24	3	18.66	5.03	18.21	1.30
464-740	13	18	3	15.00	2.64	14.85	1.18
465-731	16	38	3	26.00	11.13	24.43	1.54
467-758	10	16	3	13.00	2.99	12.76	1.26
469-683	21	28	4	24.50	3.51	24.31	1.15
469-705	12	21	3	16.66	4.50	16.24	1.32
469-749	15	21	3	17.66	3.05	17.49	1.18
471-714	15	24	3	18.33	4.93	17.92	1.29
472-680	59	79	3	66.66	10.78	66.11	1.16
476-724	12	14	2	13.00	1.41	12.96	1.11
477-758	19	23	3	21.33	2.08	21.26	1.10
479-704	11	19	3	14.66	4.04	14.30	1.31
482-699	16	23	3	19.00	3.60	18.78	1.20
488-672	12	20	3	17.00	4.35	16.58	1.32
490-646	11	14	3	12.33	1.52	12.27	1.12
490-713	20	28	3	24.33	4.04	24.10	1.18
490-730	45	49	3	47.00	1.99	46.97	1.04
495-693	12	19	3	14.66	3.78	14.36	1.27
495-809	17	22	2	19.50	3.53	19.33	1.19
498-704	79	97	3	85.00	10.39	84.59	1.12
499-724	51	72	3	58.00	12.12	57.21	1.22
501-713	33	58	3	43.00	13.22	41.74	1.34
505-741	37	68	2	52.50	21.92	50.15	1.53
509-710	18	21	3	19.33	1.52	19.29	1.08
517-692	15	36	2	25.50	14.84	23.23	1.85
517-762	9	19	3	13.66	5.03	13.05	1.45
520-790	17	29	3	23.33	6.02	22.78	1.31
521-725	18	25	3	21.66	3.51	21.47	1.18
554-668	10	13	3	11.33	1.52	11.26	1.14
585-683	9	13	3	10.33	2.30	10.17	1.29
All	7	97	119	23.01	17.47	19.00	1.77

[a] N = number of samples.

Table 8. DUSTFALL, WINTER - DECEMBER 1963 AND, JANUARY, FEBRUARY 1964 (tons/mi^2/mo)

Site coordinates	Minimum	Maximum	N[a]	Arithmetic		Geometric	
				Mean	Standard Deviation	Mean	Standard Deviation
407-770	8	19	3	14.00	5.56	13.16	1.56
421-729	11	21	3	16.00	5.00	15.46	1.38
433-565	5	10	3	7.00	2.64	6.69	1.43
435-589	5	8	3	6.33	1.52	6.21	1.26
435-717	5	9	3	7.33	2.08	7.11	1.36
436-743	6	11	3	9.00	2.64	8.70	1.38
449-719	7	19	3	12.66	6.02	11.68	1.64
451-728	7	13	3	9.66	3.05	9.35	1.36
453-701	5	12	3	8.00	3.60	7.48	1.55
457-766	7	12	3	9.66	2.51	9.43	1.31
463-691	10	17	3	13.66	3.51	13.35	1.30
464-740	10	26	3	16.66	8.32	15.38	1.62
465 731	10	15	3	12.00	2.64	11.81	1.23
467-758	7	24	3	13.00	9.53	11.03	1.96
469-683	16	20	2	18.00	2.82	17.88	1.17
469-705	10	19	3	14.00	4.58	13.51	1.38
469-749	10	20	3	15.00	5.00	14.42	1.41
471-714	15	19	3	16.33	2.30	16.22	1.14
472-680	19	35	3	28.33	8.32	27.41	1.38
476-724	13	21	3	15.66	4.61	15.25	1.31
477-758	7	16	3	10.33	4.93	9.64	1.55
479-704	9	18	3	13.66	4.50	13.13	1.42
482-699	15	21	3	18.33	3.05	18.15	1.18
488-672	13	17	3	15.33	2.08	15.23	1.15
490-646	3	13	3	8.33	5.03	7.05	2.14
490-713	20	26	3	22.66	3.05	22.53	1.14
490-730	27	51	2	39.00	16.97	37.10	1.56
495-693	11	17	3	13.00	3.46	12.71	1.28
495-709	29	65	2	47.00	25.45	43.41	1.76
495-809	9	18	3	13.66	4.50	13.13	1.42
498-704	48	88	3	74.00	22.53	71.35	1.40
499-724	45	86	3	61.33	21.73	58.97	1.40
501-713	29	52	3	39.00	11.78	37.86	1.34
505-740	78	78	1				
505-741	27	53	2	40.00	18.38	37.82	1.61
509-710	14	22	3	17.33	4.16	17.01	1.26
517-692	31	31	1				
517-762	6	12	3	8.33	3.21	7.95	1.43
520-790	18	29	3	22.00	6.08	21.48	1.29
521-725	19	28	3	24.66	4.93	24.30	1.23
554-668	8	25	3	17.66	8.73	15.87	1.82
585-683	6	12	2	9.00	4.24	8.48	1.63
All	3	88	117	19.54	16.78	15.25	1.95

[a] N = number of samples.

Table 9. DUSTFALL - YEAR, MARCH 1963-FEBRUARY 1964
(tons/mi^2/mo)

Site coordinates	Minimum	Maximum	N[a]	Arithmetic Mean	Arithmetic Standard Deviation	Geometric Mean	Geometric Standard Deviation
407-770	8	26	10	15.50	6.04	14.53	1.45
421-729	14	58	10	21.10	13.36	18.95	1.53
433-565	5	23	12	10.00	5.16	9.05	1.56
435-589	5	21	12	10.66	4.41	9.92	1.48
435-717	5	22	12	11.66	4.67	10.84	1.49
436-743	6	20	12	12.08	3.65	11.57	1.36
449-719	7	24	10	13.80	4.80	13.10	1.40
451-728	7	26	12	14.66	6.09	13.62	1.48
453-701	5	19	11	11.18	4.95	10.24	1.55
457-766	7	53	12	16.58	12.55	13.97	1.74
463-691	10	26	12	17.16	4.60	16.60	1.31
464-740	10	29	12	17.16	6.39	16.19	1.41
465-731	10	40	12	21.33	10.15	19.36	1.57
467-758	7	27	12	15.16	6.87	13.73	1.60
469-683	16	35	12	25.08	6.03	24.39	1.28
469-705	10	28	11	19.09	5.53	18.26	1.38
469-749	10	26	12	17.75	3.91	17.33	1.26
471-714	14	37	12	21.00	8.11	19.83	1.40
472-680	19	123	11	61.00	29.79	54.21	1.70
476-724	12	29	11	15.81	5.38	15.15	1.34
477-758	7	30	12	19.41	7.07	17.93	1.57
479-704	9	21	12	14.08	3.72	13.64	1.29
482-699	15	30	12	19.50	4.07	19.16	1.20
488-672	12	33	12	17.16	5.93	16.42	1.34
490-646	3	25	12	12.00	5.11	10.92	1.63
490-713	12	28	10	20.30	5.35	19.60	1.33
490-730	17	55	11	40.00	11.73	38.06	1.42
495-693	11	28	12	16.91	4.98	16.28	1.33
495-709	29	65	3	41.00	20.78	37.95	1.59
495-809	9	33	11	17.36	6.45	16.39	1.42
498-704	48	176	12	96.50	31.04	92.40	1.35
499-724	44	90	12	60.75	15.28	59.14	1.26
501-713	29	58	10	37.60	9.69	36.64	1.25
505-740	57	78	2	67.50	14.84	66.67	1.24
505-741	27	83	10	49.40	20.23	45.91	1.49
509-710	14	33	12	20.33	5.26	19.77	1.27
517-692	13	36	9	22.33	8.52	20.98	1.44
517-762	6	20	12	13.33	4.51	12.53	1.46
520-790	17	31	12	23.66	4.51	23.26	1.21
521-725	16	28	12	21.33	4.33	20.92	1.22
554-668	8	25	12	13.00	5.06	12.28	1.39
585-683	6	17	11	10.09	3.08	9.69	1.33
All	3	176	471	22.99	19.62	18.42	1.85

[a] N = number of samples.

Table 10. DUSTFALL FOR ALL STATIONS BY MONTHS
($tons/mi^2/mo$)

Month	Minimum	Maximum	N[a]	Arithmetic		Geometric	
				Mean	Standard Deviation	Mean	Standard Deviation
Feb 1963	5	135	32	29.68	27.57	22.77	2.00
Mar	12	176	38	34.57	28.75	29.12	1.68
Apr	9	126	38	29.89	24.94	24.85	1.73
May	10	94	39	24.20	21.17	19.70	1.75
June	7	83	40	21.65	15.83	18.17	1.74
July	6	105	40	19.05	17.63	15.49	1.76
Aug	7	97	40	19.55	16.23	16.01	1.79
Sept	7	97	40	20.45	17.03	16.93	1.73
Oct	10	79	39	25.94	16.23	22.79	1.60
Nov	8	79	40	22.72	19.01	17.86	1.90
Dec	3	48	39	14.84	10.50	12.05	1.90
Jan 1964	5	88	37	17.40	16.33	13.57	1.91
Feb	8	86	41	25.95	20.09	21.18	1.81

[a] N = number of samples.

The monthly and seasonal trends shown in Figure 14 generally follow the same pattern as those found in Nashville[2] and other cities. The maximum monthly geometric mean for all sites was 29.12 tons per square mile per month, which occurred in March 1963. The minimum monthly geometric mean was 12.05 tons per square mile per month in December 1963. As would be expected from these two monthly means, the spring season showed the highest geometric mean, 24.20 tons per square mile per month, and the winter season the lowest, 15.25 tons per square mile per month.

Site 433-565, which is in a low-density-residential - to - rural area, had the lowest yearly geometric mean of 9.05 tons per square mile per month. Site 498-704, which is in a very heavily industrialized area, had the highest yearly geometric mean of 92.40 tons per square mile per month.

Since dustfall measurements include relatively large particles that settle out close to their sources, stations close to large sources detect greater amounts of dustfall than stations farther away. The winter season, because of space heating, might be expected to have the most dustfall, but the spring season had the highest. This can be attributed primarily to the high wind speeds in the spring, which pick up more dust from the ground. The lack of vegetative cover and increase in construction and farm work in the spring also help explain the seasonal increase.

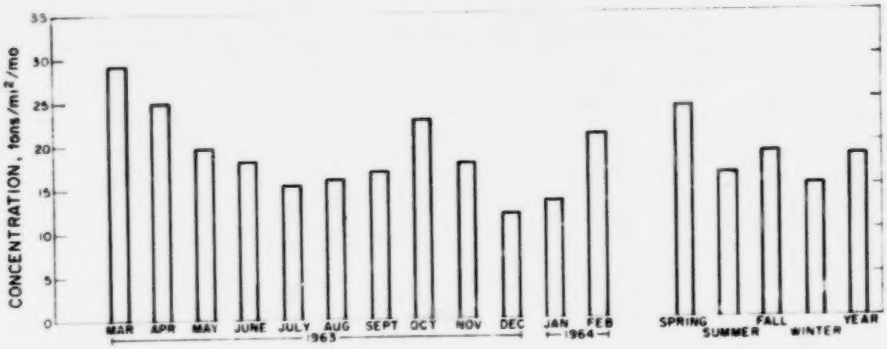

Figure 14. Dustfall - geometric means for months, seasons, and years.

Since no previous dustfall studies have been made in the St. Louis area, it is not possible to determine a trend. St. Louis would be expected to follow the trend of other similar cities in which dustfall has been reduced considerably in the past 30 years. New York City values, for instance, decreased from 162 tons per square mile per month in 1944 to 61 tons per square mile per month in 1963[3], with nearly all the reduction occurring between 1944 and 1952. Cincinnati values decreased from 54.2 tons per square mile per month in 1930-31 to 15.5 tons per square mile per month in 1963-64.[4] There was a steady decrease between 1944 and 1957 and not much change since. Chicago values decreased from 394.8 tons per square mile per month in 1928 to 43.1 tons per square mile per month in 1962.[5] The major portion of this decrease occurred between 1928 and 1935. Pollutant emission control program activities and conversion from coal to oil and natural gas for fuel, which have also taken place in St. Louis, account for the decreases.

Table 11 compares St. Louis results with results from seven other cities. Chicago, Cincinnati, New York, and Detroit results are from within the city limits; the Windsor, Nashville, and St. Louis results are from the entire metropolitan area and are, therefore, expected to be lower.

The states of New York and Oregon are the only two states known to have established dustfall objectives or standards. Oregon has the following dustfall standard: "The particle fallout rate in a residential or commercial land-use area shall not exceed the normal background values by more than 15 tons per square mile per month; excepting that in heavy-industry-land-use areas the particle fallout rate may be 30 tons per square mile per month above the normal background level . . . ."[6] Normal background levels average about 5 tons per square mile per month.

New York has established dustfall objectives that range in geometric means from 0.30 milligram per square centimeter per month (8.5 tons/mi^2/mo) in cleaner areas, to 1.5 milligrams per square centimeter per month (42.8 tons/mi^2/mo) in dirtier industrial areas.[7] There are also three other values between these two.

Table 11. DUSTFALL RESULTS FROM ST. LOUIS AND OTHER CITIES

City	Reference	Year	Dustfall,[a] tons/mi^2/mo	Remarks
Chicago	5	1962	43.1	Central city only
Cincinnati	4	1963-64	15.5[b]	
New York City	3	1963	61	
Detroit	58	1956	67[b]	
Windsor, industrial	58	1955	83.1	Metropolitan area
Commercial-residential			47.4	
Residential, semirural			35.6	
Nashville	2	1958-59	6.5[b]	Metropolitan area geometric mean
St. Louis		1963-64	20.97	Metropolitan area
Louisville	59	1956	29	

[a] Arithmetic means except as noted.

[b] Water insoluble portion only.

High dustfall values are associated with excessive soiling of automobiles, porches, window sills, and other horizontal surfaces. On the basis of the above standard and objective, some industrial and some residential areas are considered excessively dirty in the St. Louis area. Dustfall values in excess of 15 to 20 tons per square mile per month are considered detrimental by many authorities.

SUSPENDED PARTICULATES MEASURED BY HIGH-VOLUME AIR SAMPLER

High-volume air samplers were operated at 17 sites to collect suspended particulates. The results are given in Table 12. The geometric means for the year July 1963 through June 1964 ranged from 60.98 micrograms per cubic meter at site 432-715, which is in a light commercial area, to 221.81 micrograms per cubic meter at site 505-740, which is surrounded by industry and burning dumps.

Figures 15 and 16 are isopleth maps of the annual geometric means and the 99th percentile values, respectively. From the 1960 census population density (Figure 1) and the isopleth map of the annual geometric means, it was determined that approximately 84,000 people lived in areas having concentrations greater than 150 micrograms per cubic meter.

The State of Colorado has adopted an ambient air quality standard for suspended particulates of 120 micrograms per cubic meter. The standard is based on the average of samples collected at least once every third day over a 3-month period in the central business district of the city or community where a single

Table 12. SUSPENDED PARTICULATES BY HIGH-VOLUME AIR SAMPLER ($\mu g/m^3$)

Site coordinates	Minimum	Maximum	N[a]	Arithmetic Mean	Arithmetic Standard deviation	Geometric Mean	Geometric Standard deviation
July 1963 (Random schedule)							
432-715	37	122	8	70.25	30.34	64.63	1.55
438-689	48	60	2	54.00	8.48	53.66	1.17
449-719	55	158	10	84.00	30.19	80.14	1.36
468-665	23	104	12	63.33	24.91	58.29	1.56
469-750	44	97	6	60.83	18.66	58.86	1.30
470-718	76	175	8	109.00	33.59	105.10	1.32
472-680	183	1029	9	416.44	275.38	355.27	1.77
481-698	59	145	10	83.40	27.01	80.05	1.33
489-728	39	247	8	139.25	62.93	124.34	1.74
490-713	57	191	10	112.10	36.67	106.90	1.38
499-700	58	177	12	106.75	37.98	100.79	1.42
501-713	90	427	15	158.86	78.87	147.75	1.42
520-798	43	154	7	101.28	41.35	93.01	1.59
534-702	40	156	12	83.66	41.36	75.42	1.59
Aug (Random schedule)							
432-715	42	102	7	75.85	18.75	73.53	1.32
438-689	43	140	7	93.00	34.52	87.19	1.49
449-719	68	133	6	99.16	26.67	96.13	1.31
468-665	37	111	7	83.00	25.82	78.61	1.46
469-750	36	118	6	81.16	30.22	75.71	1.53
472-680	105	334	6	238.66	87.00	222.61	1.54
481-698	53	151	8	108.87	32.93	103.88	1.40
489-728	110	255	6	170.83	50.44	164.90	1.33
490-713	81	224	7	163.14	53.53	154.12	1.46
499-700	57	996	7	251.00	335.56	150.98	2.67
501-713	76	251	8	163.50	58.12	154.04	1.46
520-798	38	116	5	82.80	36.29	75.28	1.66
534-702	22	189	6	92.83	73.84	66.21	2.60
Sept (Weekday schedule)							
432-715	45	112	23	71.43	18.94	69.05	1.30
438-689	49	206	20	97.65	35.22	92.40	1.40
449-719	44	172	18	95.55	31.24	90.67	1.40
468-665	43	152	23	91.65	26.81	87.71	1.36
469-750	70	123	4	99.25	23.34	97.05	1.28
470-718	58	230	18	114.55	40.28	108.41	1.40
472-680	35	539	17	275.70	131.97	238.36	1.88
481-698	69	211	19	124.52	40.93	118.34	1.39
489-728	12	392	16	169.06	98.15	135.68	2.24
490-713	91	282	17	188.47	45.20	182.69	1.30
499-700	71	741	19	202.36	145.34	173.61	1.69
501-713	47	443	17	203.76	101.74	179.73	1.71
520-798	47	265	20	115.55	63.87	100.89	1.69
534-702	25	164	9	78.66	45.54	66.61	1.89

[a] N = number of samples.

Table 12. (Cont'd) SUSPENDED PARTICULATES BY HIGH-VOLUME AIR SAMPLER (μg/m^3)

Site coordinates	Minimum	Maximum	N[a]	Arithmetic Mean	Arithmetic Standard deviation	Geometric Mean	Geometric Standard deviation
Oct (Weekday schedule)							
468-665	61	229	25	138.68	42.61	131.69	1.40
432-715	45	143	25	91.20	25.96	87.53	1.34
438-689	50	179	24	110.20	34.20	104.45	1.41
449-719	52	242	23	142.30	42.80	135.49	1.39
469-750	67	189	10	130.00	41.52	123.29	1.42
470-718	41	248	19	135.26	55.36	122.08	1.65
472-680	10	767	22	312.77	198.24	238.45	2.51
481-698	61	217	25	141.92	37.90	136.25	1.35
489-728	88	642	12	233.75	144.77	204.02	1.69
490-713	81	288	23	205.73	56.29	196.06	1.41
499-700	105	433	21	193.66	87.10	179.57	1.45
501-713	130	366	20	245.05	66.15	235.39	1.35
520-798	67	334	15	171.53	68.30	158.18	1.54
534-702	82	207	6	140.00	43.17	134.39	1.37
Nov (Weekday schedule)							
432-715	14	152	18	65.88	34.05	57.65	1.74
438-689	17	147	19	61.73	30.54	54.94	1.66
449-719	22	223	15	87.60	51.56	74.43	1.83
468-665	19	220	21	69.23	44.48	59.67	1.71
469-750	28	229	19	91.21	51.37	78.97	1.74
470-718	19	205	13	103.92	62.58	83.45	2.12
472-680	11	488	19	194.15	146.15	133.71	2.74
481-698	12	161	24	83.08	36.75	73.57	1.75
489-728	26	294	9	170.00	92.95	137.34	2.21
490-713	74	435	17	161.94	106.27	138.48	1.72
495-709	42	207	9	117.33	51.26	105.87	1.66
499-700	90	379	9	203.00	111.57	177.97	1.71
501-713	70	333	15	195.40	84.15	177.03	1.61
505-740	104	778	10	298.40	200.00	252.39	1.80
520-798	83	276	16	155.43	63.88	143.99	1.49
534-702	19	251	14	98.92	59.70	82.74	1.92
Dec (Weekday schedule)							
432-715	30	186	20	74.20	41.97	65.98	1.60
438-689	28	150	19	57.21	28.06	52.36	1.51
449-719	23	175	21	70.52	39.95	60.66	1.76
468-665	34	199	21	80.04	43.67	70.55	1.65
469-750	33	173	19	88.94	37.34	81.77	1.53
470-718	12	306	13	98.92	80.14	73.41	2.32
472-680	52	499	14	181.92	125.31	147.61	1.96
481-698	46	253	17	98.41	52.08	88.41	1.58
489-728	60	187	8	98.87	42.23	92.19	1.47
490-713	63	220	19	121.73	44.36	114.69	1.42
495-709	73	258	17	146.76	54.64	137.56	1.45
501-713	100	223	17	164.17	40.32	159.22	1.29
505-740	71	1066	18	215.77	230.34	163.05	1.96
520-798	27	372	21	139.71	73.94	122.36	1.74
534-702	35	177	14	101.42	48.36	88.89	1.76

Table 12. (Cont'd) SUSPENDED PARTICULATES BY HIGH-VOLUME AIR SAMPLER ($\mu g/m^3$)

Site coordinates	Minimum	Maximum	N[a]	Arithmetic		Geometric	
				Mean	Standard deviation	Mean	Standard deviation
Jan 1964 (Weekday schedule)							
432-715	37	106	25	63.68	21.72	60.19	1.40
438-689	28	111	10	54.90	29.28	49.05	1.62
449-719	32	178	19	79.10	44.72	69.16	1.68
468-665	33	151	25	71.80	29.66	66.50	1.48
469-750	55	193	9	106.22	48.45	96.93	1.57
472-680	86	1337	19	436.42	336.36	337.55	2.09
481-698	54	246	23	111.56	53.92	101.05	1.55
490-713	77	302	18	150.16	60.15	140.07	1.45
494-703	93	327	16	165.62	56.89	157.70	1.37
495-709	72	308	22	146.36	64.28	134.64	1.50
501-713	88	373	21	199.28	77.96	185.84	1.46
505-740	98	622	20	338.20	165.51	291.72	1.82
520-798	81	430	24	185.12	80.42	170.91	1.49
534-702	25	248	19	114.57	57.76	100.50	1.74
Feb (Weekday schedule)							
432-715	30	130	22	63.54	28.23	58.36	1.51
438-698	23	142	20	58.55	26.49	53.60	1.53
449-719	32	248	21	88.66	57.81	73.86	1.84
468-665	26	87	17	48.76	14.79	46.73	1.35
469-750	43	182	22	95.81	38.58	89.15	1.46
470-718	35	202	13	75.61	47.41	65.57	1.69
472-680	43	733	17	198.64	176.04	147.41	2.18
481-698	45	271	22	94.86	54.34	84.48	1.58
489-728	66	232	15	102.26	43.22	96.18	1.40
490-713	80	268	17	151.88	63.25	139.95	1.51
494-703	96	406	15	182.46	75.04	170.95	1.43
495-709	80	414	18	189.50	80.93	175.15	1.49
501-713	108	417	18	203.50	78.13	191.45	1.42
505-740	78	624	18	205.05	118.78	183.77	1.57
520-798	58	235	18	137.00	51.19	127.82	1.48
534-702	41	258	10	124.70	60.82	111.01	1.70
Mar (Weekday schedule)							
432-715	23	122	23	56.52	23.14	51.90	1.54
438-689	18	124	21	68.42	26.39	62.37	1.61
449-719	15	151	18	82.77	37.98	72.17	1.82
468-665	16	98	22	45.31	18.98	41.82	1.51
469-750	31	151	23	85.08	33.87	77.99	1.56
470-718	57	162	2	109.50	74.24	96.09	2.09
472-680	55	975	14	287.50	279.05	197.62	2.37
481-698	23	196	23	97.43	45.45	86.66	1.68
489-728	30	147	18	87.27	36.69	79.44	1.58
490-713	62	241	18	134.27	51.04	124.76	1.49
494-703	63	318	12	159.75	74.22	145.54	1.56
495-709	74	417	21	162.19	75.57	149.56	1.48
501-713	67	267	16	162.75	55.85	152.46	1.47
505-740	89	604	10	260.20	172.98	215.82	1.90
520-798	49	314	21	169.19	73.20	152.57	1.63
534-702	50	181	11	87.27	39.15	80.81	1.48

Table 12. (Cont'd) SUSPENDED PARTICULATES BY HIGH-VOLUME AIR SAMPLER ($\mu g/m^3$)

Site coordinates	Minimum	Maximum	N[a]	Arithmetic Mean	Arithmetic Standard deviation	Geometric Mean	Geometric Standard deviation
Apr (Random schedule)							
432-715	34	105	8	69.12	24.59	65.02	1.46
438-689	34	132	9	76.33	32.82	70.32	1.54
449-719	78	131	6	107.16	21.45	105.26	1.23
468-665	15	98	8	48.62	27.27	42.00	1.81
469-750	33	150	7	87.85	39.32	79.59	1.65
472-680	23	926	4	295.50	422.72	130.12	4.55
481-698	55	255	8	133.00	68.06	118.69	1.66
489-728	39	188	13	99.92	52.98	87.97	1.69
490-713	58	193	7	125.00	46.95	116.94	1.50
494-703	78	451	15	187.80	113.06	161.05	1.75
495-709	79	264	8	155.62	62.08	145.58	1.47
501-713	92	248	8	146.75	58.37	137.59	1.45
505-740	71	502	7	263.00	146.22	223.75	1.93
520-798	80	302	6	161.83	83.77	145.03	1.66
534-702	79	101	5	89.00	9.13	88.63	1.10
May (Random schedule)							
432-715	44	489	6	145.16	170.85	98.69	2.36
438-689	51	131	6	90.83	27.49	87.12	1.38
449-719	55	145	4	88.75	39.33	83.04	1.50
468-665	52	99	6	64.50	17.53	62.87	1.26
469-750	56	186	6	102.50	47.24	94.60	1.53
470-718	82	119	3	98.66	18.77	97.50	1.20
489-728	186	186	1				
490-713	126	126	1				
495-709	146	247	4	179.00	46.22	175.05	1.26
501-713	154	287	6	210.66	44.01	207.00	1.22
505-740	253	459	5	338.00	80.76	330.66	1.26
June (Random schedule)							
432-715	25	109	7	57.42	27.37	52.21	1.60
438-689	44	183	8	83.75	43.86	76.26	1.55
449-719	22	139	7	104.28	43.18	91.08	1.94
468-665	31	149	5	69.40	46.15	60.00	1.78
469-750	42	109	8	70.62	24.54	67.07	1.40
470-718	33	98	5	62.00	23.42	58.46	1.47
490-713	132	146	3	138.00	7.21	137.87	1.05
495-709	79	134	6	102.66	18.41	101.34	1.19
501-713	131	285	7	195.00	49.59	189.81	1.28
505-740	141	254	7	191.28	40.72	187.57	1.23

Table 12. (Cont'd) SUSPENDED PARTICULATES BY HIGH-VOLUME AIR SAMPLER ($\mu g/m^3$)

Site coordinates	Minimum	Maximum	N[a]	Arithmetic		Geometric	
				Mean	Standard deviation	Mean	Standard deviation
Summer '63 (Random schedule)							
432-715	27	122	32	69.71	18.97	67.20	1.32
438-689	43	140	9	84.33	34.62	78.27	1.50
449-719	52	158	34	81.41	23.83	78.53	1.30
468-665	23	118	28	75.35	23.91	70.79	1.47
469-750	36	133	32	76.03	22.64	72.91	1.34
470-718	31	175	19	91.84	32.89	86.15	1.46
472-680	96	1029	36	309.25	197.37	266.92	1.69
481-698	53	151	22	92.63	28.95	88.60	1.35
489-728	39	255	25	137.84	48.39	129.49	1.45
490-713	57	224	40	118.82	38.53	113.50	1.34
499-700	30	996	41	128.51	145.48	104.73	1.70
501-713	76	427	31	164.61	63.25	155.79	1.38
520-798	30	246	37	133.18	58.86	118.31	1.70
534-702	22	189	26	96.46	49.47	82.85	1.82
Fall '63 (Weekday schedule)							
432-715	14	152	66	77.40	28.21	71.92	1.50
438-689	17	206	63	91.60	38.78	82.77	1.61
449-719	22	242	56	112.62	48.43	101.43	1.63
468-665	19	229	69	101.86	48.14	90.38	1.67
469-750	28	229	33	103.93	48.28	92.67	1.65
470-718	19	248	50	119.66	53.08	105.95	1.72
472-680	10	767	58	263.05	169.40	197.26	2.47
481-698	12	217	68	116.29	45.69	105.38	1.64
489-728	12	642	37	190.27	115.19	155.33	2.08
490-713	74	435	57	187.52	73.42	173.06	1.51
495-709	42	207	9	117.33	51.26	105.87	1.66
499-700	71	741	49	198.75	114.79	176.95	1.58
501-713	47	443	52	217.23	85.59	198.51	1.57
505-740	104	778	10	298.40	200.00	252.39	1.80
520-798	47	334	51	144.52	68.36	128.75	1.64
534-702	19	251	29	101.13	55.40	85.52	1.87
Winter '63-64 (Weekday schedule)							
432-715	30	186	67	66.77	30.92	61.24	1.50
438-689	23	150	49	57.28	27.12	52.16	1.53
449-719	23	248	61	79.44	48.00	67.62	1.76
468-665	26	199	63	68.33	34.18	61.66	1.55
469-750	33	193	50	95.08	39.64	87.58	1.50
470-718	12	306	26	87.26	65.60	69.38	2.00
472-680	43	1337	50	284.32	265.25	202.03	2.29
481-698	45	271	62	102.03	53.23	91.42	1.57
489-728	60	232	23	101.08	41.94	94.77	1.41
490-713	63	302	54	140.70	56.89	130.52	1.47
494-703	93	406	31	173.77	65.72	163.98	1.40
495-709	72	414	57	160.10	69.26	147.24	1.50
501-713	88	417	56	189.98	69.77	179.02	1.40
505-740	71	1066	56	256.05	184.55	208.57	1.87
520-798	27	430	63	156.23	73.51	140.71	1.60
534-702	25	258	43	112.65	54.99	98.82	1.72

[a] N = number of samples.

Table 12. (Cont'd) SUSPENDED PARTICULATES BY HIGH-VOLUME AIR SAMPLER ($\mu g/m^3$)

Site coordinates		Minimum	Maximum	N[a]	Arithmetic		Geometric	
					Mean	Standard deviation	Mean	Standard deviation
Spring '64 (Random schedule)								
520-798		69	314	14	180.71	86.32	160.63	1.68
432-715		28	489	23	82.65	92.08	65.03	1.81
438-689		26	132	23	74.52	30.82	68.03	1.57
449-719		33	151	16	94.25	35.87	86.66	1.56
468-665		15	99	23	51.08	22.81	46.08	1.61
469-750		31	186	36	88.52	36.69	80.86	1.56
470-718		95	162	3	125.33	33.94	122.34	1.30
472-680		23	926	10	284.60	307.27	164.78	3.13
481-698		41	255	17	115.29	62.69	100.29	1.73
489-728		39	188	11	100.54	52.67	88.35	1.71
490-713		58	190	13	123.23	43.97	115.42	1.47
494-703		63	340	10	157.50	94.74	137.13	1.71
495-709		74	264	19	157.89	56.37	148.03	1.45
501-713		85	287	18	170.00	58.47	160.03	1.44
505-740		71	502	14	286.50	16.42	259.77	1.65
534-702		52	126	9	90.11	21.83	87.59	1.29
July '63-June '64 (Random schedule)								
432-715		14	489	89	69.39	51.67	60.98	1.60
438-689		17	183	74	72.81	33.94	65.15	1.62
449-719		22	171	81	83.61	37.95	74.29	1.67
468-665		15	220	85	67.22	35.55	59.39	1.65
469-750		28	186	71	81.16	33.89	74.76	1.50
470-718		33	205	34	98.20	49.96	86.20	1.69
472-689		11	1337	63	303.55	274.16	207.73	2.55
481-698		27	255	77	96.75	42.66	88.39	1.53
489-728		12	311	44	123.75	64.22	106.48	1.82
490-713		57	435	65	139.47	62.25	128.27	1.50
494-703		63	340	19	158.42	69.44	146.35	1.49
495-709		42	264	45	143.75	51.72	134.64	1.45
499-700		67	332	21	166.52	75.26	151.27	1.57
501-713		76	355	69	176.42	62.04	165.97	1.42
505-740		71	502	39	246.25	110.83	221.81	1.61
520-798		27	334	63	135.23	70.28	118.04	1.72
534-702		22	258	42	102.33	49.16	91.70	1.62
July 1963	All	23	1029	129	121.71	117.55	98.03	1.81
Aug	All	22	996	86	131.98	114.62	108.33	1.82
Sept	All	12	741	240	138.22	92.15	116.44	1.78
Oct	All	10	767	270	169.93	99.54	148.32	1.69
Nov	All	11	778	247	124.88	99.64	95.97	2.08
Dec	All	12	1066	258	114.56	91.20	93.90	1.85
Jan 1964	All	25	1337	270	160.72	151.37	121.84	2.04
Feb	All	23	733	283	124.19	89.36	100.93	1.89
Mar	All	15	973	273	119.76	103.67	94.36	1.96
Apr	All	15	926	119	132.77	111.96	106.04	1.92
May	All	44	489	48	146.89	104.67	119.61	1.87
June	All	22	285	63	107.26	60.49	91.10	1.81
Summer	All	22	1029	412	124.33	103.53	103.81	1.74
Fall	All	10	778	757	145.18	99.04	119.17	1.90
Winter	All	12	1337	811	133.28	115.85	105.02	1.94
Spring	All	15	926	245	126.93	105.71	100.14	1.95
Year	Random	11	1337	981	124.16	107.75	98.77	1.92
Year	All	10	1337	2298	134.49	107.56	107.86	1.92

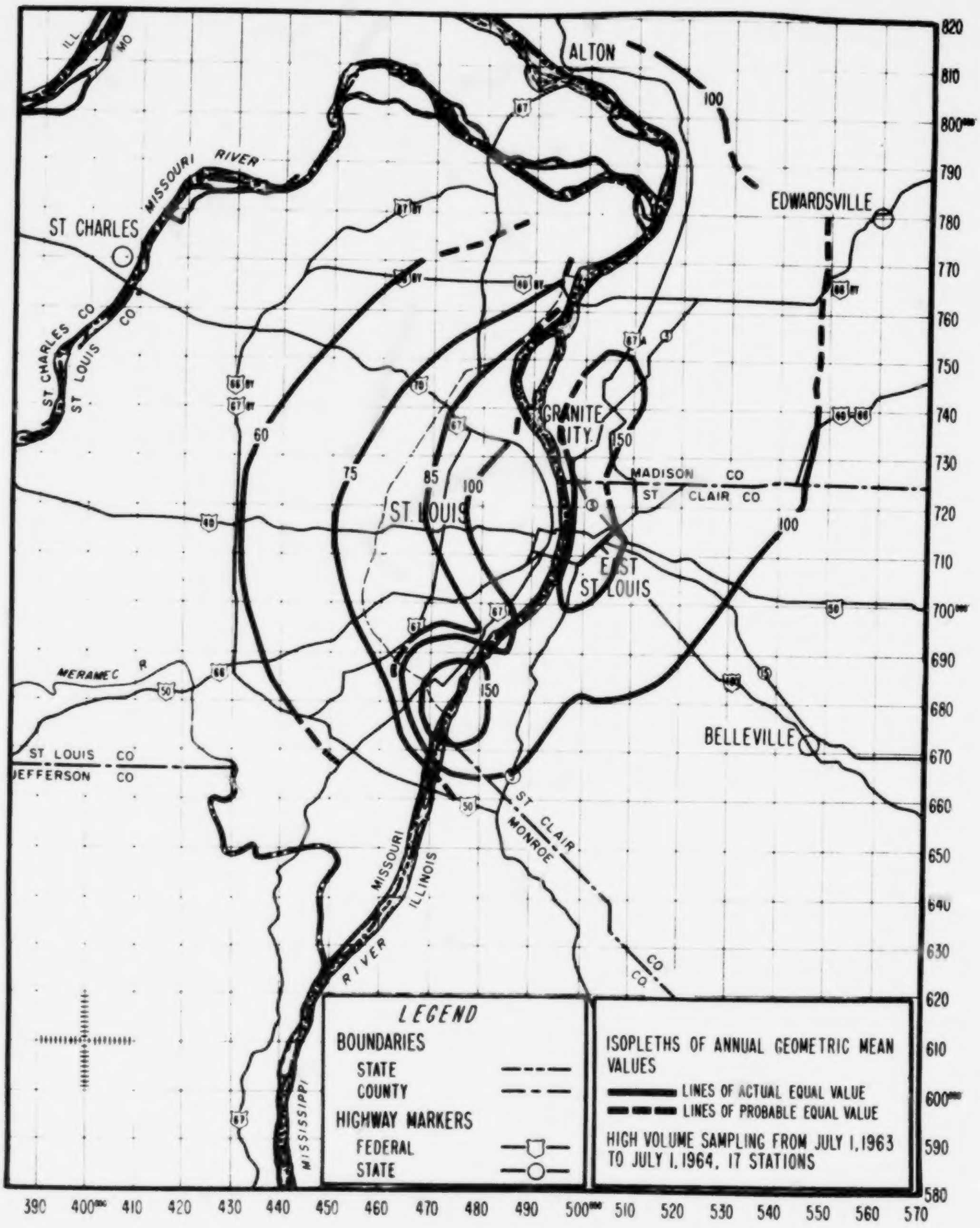
ILL
MO
ALTON
100
EDWARDSVILLE
MISSOURI RIVER
ST CHARLES
ST CHARLES CO
ST LOUIS CO
60
75
85
100
GRANITE CITY
150
MADISON CO
ST CLAIR CO
ST. LOUIS
EAST ST. LOUIS
100
MERAMEC R
150
BELLEVILLE
ST LOUIS CO
JEFFERSON CO
ST CLAIR
MONROE
CO
CO
MISSOURI
ILLINOIS
RIVER
MISSISSIPPI
LEGEND
BOUNDARIES
STATE
COUNTY
HIGHWAY MARKERS
FEDERAL
STATE
ISOPLETHS OF ANNUAL GEOMETRIC MEAN VALUES
LINES OF ACTUAL EQUAL VALUE
LINES OF PROBABLE EQUAL VALUE
HIGH VOLUME SAMPLING FROM JULY 1, 1963 TO JULY 1, 1964, 17 STATIONS
820
810
800
790
780
770
760
750
740
730
720
710
700
690
680
670
660
650
640
630
620
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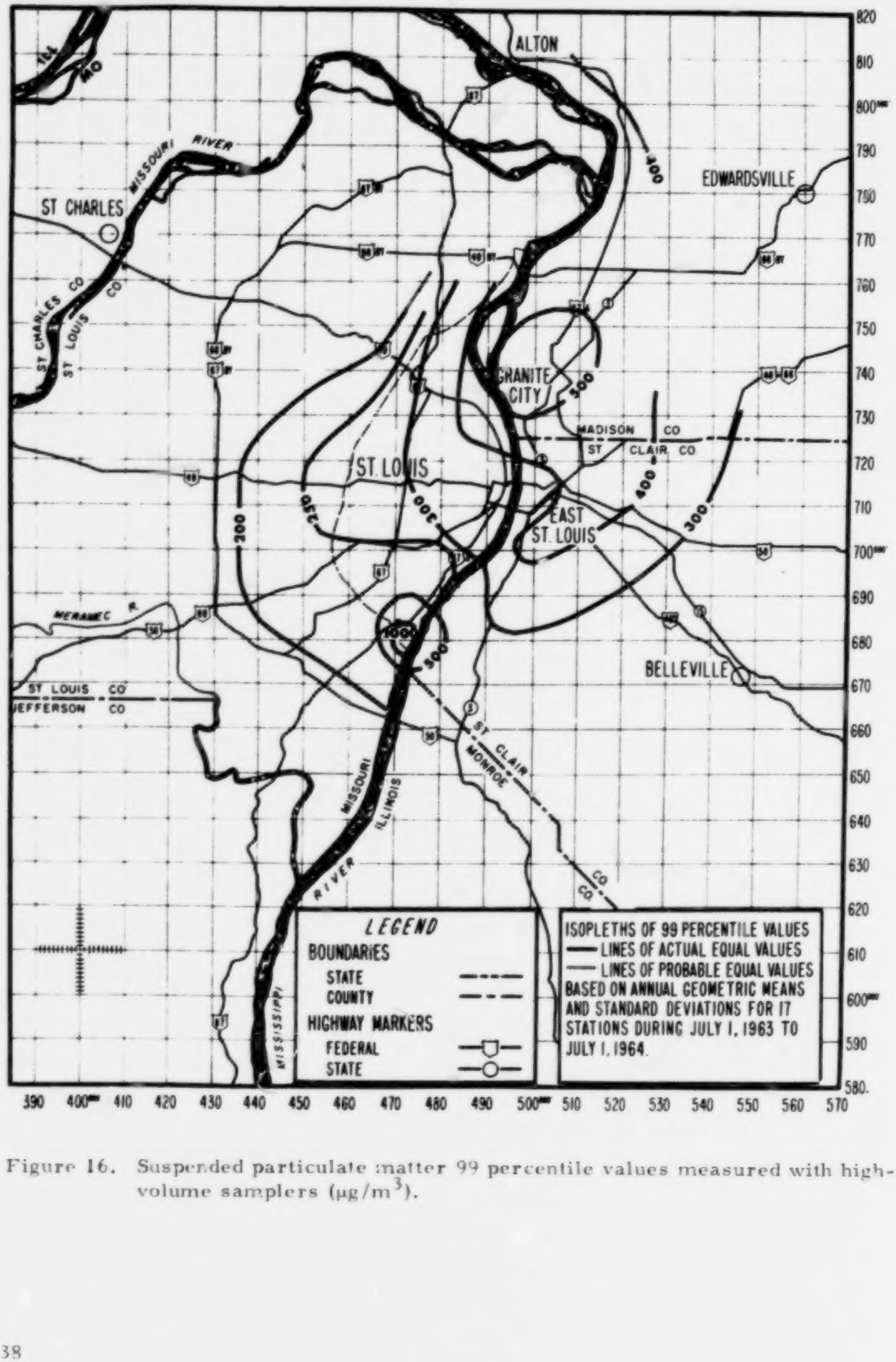
Figure 15. Annual geometric means of particulate matter measured with high-volume samplers ($\mu g/m^3$).


ALTON
EDWARDSVILLE
ST CHARLES
MISSOURI RIVER
ST CHARLES CO
ST LOUIS CO
GRANITE CITY
MADISON CO
ST CLAIR CO
ST. LOUIS
EAST ST. LOUIS
BELLEVILLE
MERAMEC R.
ST LOUIS CO
JEFFERSON CO
ST CLAIR CO
MONROE CO
MISSOURI
ILLINOIS
RIVER
MISSISSIPPI
MO
ILL
400
500
200
250
300
400
300
1000
500
LEGEND
BOUNDARIES
STATE
COUNTY
HIGHWAY MARKERS
FEDERAL
STATE
ISOPLETHS OF 99 PERCENTILE VALUES
LINES OF ACTUAL EQUAL VALUES
LINES OF PROBABLE EQUAL VALUES
BASED ON ANNUAL GEOMETRIC MEANS
AND STANDARD DEVIATIONS FOR 17
STATIONS DURING JULY 1, 1963 TO
JULY 1, 1964.
820
810
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770
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730
720
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Figure 16. Suspended particulate matter 99 percentile values measured with high-volume samplers (μg/m^3).

emission source is not the prime polluter.[8] The State of Oregon has established a maximum concentration of 150 micrograms per cubic meter for residential and commercial areas and 250 micrograms per cubic meter for industrial areas, both above normal background levels.[6] Background levels in rural Missouri average approximately 30 micrograms per cubic meter.[9] This, based on the Oregon standard would make the limits 180 and 280 micrograms per cubic meter for St. Louis. The State of New York has adopted ambient air quality objectives that range in geometric means from 40 micrograms per cubic meter in cleaner areas to 135 micrograms per cubic meter in dirtier industrial areas.[7] There are five additional objectives between these two. Since the New York and Colorado standards are more recent than the Oregon requirement, there appears to be a trend toward lower values. There is also a trend away from the use of single-number standards. Standards should relate to effects; therefore, frequency and duration of occurrence as well as level of pollution should be established in the standards.

Site 490-713 in downtown St. Louis exceeded the Colorado standard three out of four seasons; whereas site 501-713 in downtown East St. Louis exceeded it in all four seasons. The Oregon standards were exceeded by all the sites except sites 449-719 (residential-commercial) and 495-709 (industrial). The sites used in this Study cannot be classified exactly according to the New York classification system. Sites 472-680, 494-703, and 499-700, however, which are in industrial areas, had geometric means that exceeded the New York poorest-air-quality objective of 135 micrograms per cubic meter.

The monthly, seasonal, and yearly geometric means for all sites given in Figure 17 show October as the maximum month with 148.32 micrograms per cubic meter, and June, the lowest with 91.10 micrograms per cubic meter. Fall was the highest season with 119.17 micrograms per cubic meter, and spring, the lowest with 100.14 micrograms per cubic meter. The yearly geometric mean based on random days was 98.77 micrograms per cubic meter and 107.86 micrograms per cubic meter based on all results. If weekday sampling schedule results are used for the fall and winter seasons, the yearly mean is lower than any of the seasonal means. This is because the weekday sampling schedule was used to determine the fall and winter means and the 100-day random sampling schedule to determine the spring, summer, and yearly means. This approach was taken to prevent biasing the yearly mean with more winter and fall results than spring and summer results.

Since the weekday sampling schedule provides more data than the random schedule, it has greater validity. As the data are used the conservative nature of the yearly mean should be considered. This would justify increasing the yearly mean as much as 7 micrograms per cubic meter, or from 98.77 to about 105.

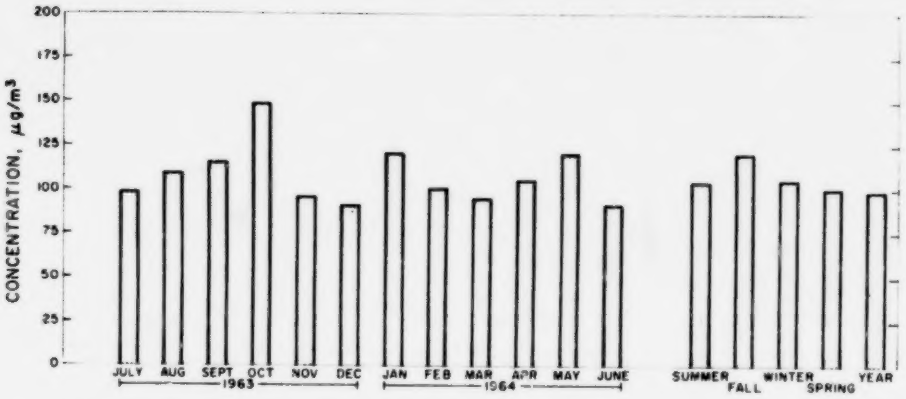


Figure 17. Suspended particulate geometric means for months, seasons, and year-measured with high-volume samplers.

A statistical comparison of the results from the weekday and random schedules was made to determine the validity of the random schedule. This comparison showed that the 100-day random-sampling schedule could be used to estimate annual and season means within ± 20 percent of the true geometric mean at 95 percent confidence limits. A random schedule of 250 to 300 days would be required to estimate monthly means with the same degree of confidence. The details of this statistical comparison are given in the Interstate Air Pollution Study, Memorandum of Information and Instruction No. 14, "Comparison of Hi-Vol Particulate Measurement Using Random and Weekday Schedules July 1963 Through June 1964." Table 13 compares the results of the random and weekday schedules by station and seasons, and Table 14 indicates the percent difference between the random and weekday sampling results. Use of these tables will guide the user regarding the degree of confidence that can be placed in the data for use in specific places or specific time intervals.

Figures 18 through 33 give the suspended particulate frequency distributions for the year and seasons at each of the sampling sites. A test of the data from ten of the sites was made to determine whether the geometric mean and its standard deviation or the arithmetic mean and its standard deviation described the data better. For all ten sites, the geometric means were nearer to the 50th percentile value than were the arithmetic means. For nine of the sites, each set of the ten fractiles (10th percentile, 20th percentile, etc.) described an approximate straight line very close to the line determined by the particular site's geometric mean and its standard deviation. Zimmer, Tabor, and Stern[10] also found this to be true of the National Air Sampling Network data. The conclusion reached was that the geometric mean and its standard deviation should be used to describe each station's data distribution.

Table 13. ANNUAL, SEASONAL, MONTHLY, GEOMETRIC MEANS

Site coordinates	Annual	Spring	Summer	Fall	Winter	1963						1964						Schedule[a]
						July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	
432 715	60.98	65.03	62.17	66.01	52.60	62.58	73.53	66.39	91.48	51.41	59.58	51.65	48.83	49.24	65.02	98.69	52.21	A
	-	-	-	71.92	61.24	-	-	69.05	87.53	57.65	65.98	60.19	58.36	51.90	-	-	-	B
438 689	65.15	68.03	67.89	71.72	45.92	48.00	87.19	82.38	116.64	51.87	49.33	-	43.44	54.93	71.88	87.12	74.60	A
	-	-	-	82.77	52.16	-	-	92.40	104.45	54.94	52.36	49.05	53.60	62.37	-	-	-	B
449 719	74.29	86.66	87.39	81.02	54.81	79.41	96.13	76.89	139.39	57.51	54.09	62.72	50.41	73.42	105.26	83.04	91.08	A
	-	-	-	101.43	67.62	-	-	90.67	135.49	74.43	60.66	69.16	73.86	72.17	-	-	-	B
468 665	59.39	46.08	66.52	79.25	52.90	65.19	74.22	80.97	120.28	63.37	63.04	54.92	43.90	40.68	42.00	62.87	60.00	A
	-	-	-	90.38	61.66	-	-	87.71	131.69	59.67	70.55	66.50	46.73	41.82	-	-	-	B
469 750	74.76	-	67.80	71.05	77.91	53.26	87.85	112.00	115.00	64.70	79.03	70.00	77.86	72.60	-	-	-	A
	-	-	-	92.67	87.58	-	-	97.05	123.29	78.97	81.77	96.93	89.15	77.99	-	-	-	B
470 718	86.20	122.34	85.45	108.86	60.56	110.54	-	92.95	160.36	109.27	44.89	-	68.85	162.00	-	106.32	58.08	A
	-	-	-	105.95	69.38	-	-	108.41	122.08	83.45	73.41	73.41	65.57	96.09	-	-	-	B
472 680	207.73	164.78	294.68	189.23	195.46	355.27	222.61	260.48	384.28	106.90	139.35	489.02	121.39	192.88	130.12	-	-	A
	-	-	-	197.26	202.03	-	-	238.36	238.45	133.71	147.61	337.55	147.41	197.62	-	-	-	B
481 698	88.39	100.29	92.74	88.71	77.15	82.81	107.27	100.96	123.58	71.11	79.98	87.74	70.54	86.35	118.69	-	-	A
	-	-	-	105.38	91.42	-	-	118.34	136.25	73.57	88.41	101.05	84.48	86.66	-	-	-	B
489 728	106.48	88.35	134.36	114.01	92.19	112.73	164.90	108.72	88.00	206.00	80.49	-	95.01	86.75	80.06	186.00	-	A
	-	-	-	155.33	94.77	-	-	135.68	204.02	137.34	92.19	-	96.18	79.44	-	-	-	B
490 713	128.27	115.42	129.23	154.85	113.91	109.09	154.12	166.26	194.49	133.60	99.73	117.22	124.08	117.22	110.99	126.00	146.00	A
	-	-	-	173.06	130.52	-	-	182.69	196.06	138.48	114.69	140.07	139.95	124.76	-	-	-	B
494 703	146.35	137.13	-	-	157.32	-	-	-	-	-	-	145.86	163.39	131.15	146.63	-	-	A
	-	-	-	-	163.98	-	-	-	-	-	-	157.70	170.95	145.54	-	-	-	B
495 709	134.64	148.03	-	87.43	144.46	-	-	-	-	87.43	150.79	116.00	163.89	135.39	148.95	175.05	101.34	A
	-	-	-	105.87	147.24	-	-	-	-	105.87	137.56	134.64	175.15	149.56	-	-	-	B
499 700	151.27	-	113.79	161.76	-	95.09	195.00	143.29	178.28	168.39	-	-	-	-	-	-	-	A
	-	-	-	176.95	-	-	-	173.61	179.57	177.97	-	-	-	-	-	-	-	B
501 713	165.97	160.03	162.22	178.13	164.22	130.91	163.33	174.27	218.70	159.37	157.70	159.41	172.48	164.30	137.59	208.10	209.93	A
	-	-	-	198.51	179.02	-	-	179.73	235.39	177.03	159.22	185.84	191.45	152.46	-	-	-	B
505 740	221.81	259.77	-	201.64	210.38	-	-	-	-	201.64	170.46	400.39	169.06	239.59	223.75	330.66	187.57	A
	-	-	-	252.39	208.57	-	-	-	-	252.39	163.05	291.72	183.77	215.82	-	-	-	B
520 798	118.04	160.63	85.17	122.61	112.98	93.01	75.28	94.77	249.24	124.84	104.06	150.97	98.69	173.42	145.03	-	-	A
	-	-	-	128.75	140.71	-	-	100.89	158.18	143.99	122.36	170.91	127.82	152.57	-	-	-	B
534 702	91.70	87.59	82.23	95.94	98.09	87.90	71.98	79.02	121.00	101.71	73.89	85.91	140.49	86.32	88.63	-	-	A
	-	-	-	85.52	98.82	-	-	66.61	134.39	82.74	88.89	100.50	111.01	80.81	-	-	-	B
All sites	98.77	100.14	98.56	105.54	91.83	99.47	109.81	108.43	154.91	86.76	85.19	114.02	86.72	92.26	101.24	117.76	87.70	A
	-	-	-	119.17	105.02	-	-	116.44	148.32	95.97	93.90	121.84	100.93	94.36	-	-	-	B

[a] A = random schedule geometric mean.

B = weekday schedule geometric mean.

Table 14. PERCENT VARIATION OF RANDOM SAMPLING FROM WEEKDAY SAMPLING

Period	Site coordinates																	Schedule[a]
	432-715	438-689	449-719	468-665	469-750	470-718	472-680	481-698	489-728	490-713	494-703	495-709	4[illegible]-700	501-713	505-740	520-798	534-702	
Fall	-8.2	-13.3	-20.1	-12.3	-23.3	+2.7	-4.1	-15.8	-26.6	-10.5	-	-	-8.6	-10.3	-	-4.8	+12.2	
	21	20	18	22	12	11	19	22	9	18			17	17		15	10[b]	A
	66	63	56	69	33	50	58	68	37	57			49	52		51	29[b]	B
Winter	-14.1	-12.0	-19.0	-14.2	-11.0	-12.7	-3.2	-15.6	-2.7	-12.7	-4.1	-1.9	-	-8.3	+0.9	-19.6	-0.7	
	24	16	25	22	19	10	19	22	11	18	9	17		19	16	22	14	A
	67	49	61	63	50	26	50	62	23	54	31	57		56	56	63	43	B
Sept	-3.9	-10.9	-15.2	-7.7	+15.4	-14.3	+9.3	-14.7	-19.8	-9.0	-	-	-17.5	-3.0	-	-5.6	+18.7	
	7	7	6	7	1	5	5	6	7	7			6	7		6	3	A
	23	20	18	23	4	18	17	19	16	17			19	17		20	9	B
Oct	+4.5	+11.7	+2.9	-8.7	-6.7	+31.3	+61.0	-9.3	-56.7	-0.8	-	-	-0.7	-7.1	-	+57.5	-10.0	
	6	4	5	5	1	2	5	5	1	3			5	4		2	1	A
	25	24	23	25	10	19	22	25	12	23			21	20		15	6	B
Nov	-10.8	-5.6	-22.8	+7.9	-18.0	+31.0	-20.0	-3.3	+50.0	-3.5	-	-17.5	-5.4	-10.0	-20.0	-13.3	+22.9	
	8	9	7	10	10	4	9	11	1	8		3	6	6	2	7	6	A
	18	19	15	21	19	13	19	24	9	17		9	9	15	10	16	14	B
Dec	-9.7	-5.8	-9.2	-10.6	-3.4	-38.8	-5.6	-9.5	-12.7	-13.0	-	+9.5	-	-1.0	+4.5	-15.0	-16.9	
	7	7	8	7	8	3	5	7	2	6		5		6	6	8	4	A
	20	19	21	21	19	13	14	17	8	19		17		17	18	21	14	B
Jan	-14.2	-	-9.3	-17.4	-27.8	-	+45.0	-13.2	-	-16.3	-7.5	-13.9	-	-14.2	+37.3	-11.7	-14.5	
	7		7	7	1		6	5		4	3	5		5	4	6	5	A
	25		19	25	9		19	23		18	16	22		21	20	24	19	B
Feb	-16.3	-19.0	-31.8	-6.1	-12.6	+5.0	-17.6	-16.4	-1.2	-11.3	-4.4	-6.4	-	-9.9	-8.0	-22.8	+26.5	
	10	9	10	8	10	7	8	10	9	8	6	7		8	6	8	5	A
	22	20	21	17	22	13	17	22	15	17	15	18		18	18	18	10	B
Mar	-5.1	-11.9	+1.7	-2.7	-6.9	-	-2.4	-0.4	+9.2	-6.0	-9.9	-9.5	-	+7.8	+11.0	+13.6	+6.8	
	9	9	6	9	9	1	6	9	3	7	6	8		6	2	8	4	A
	23	21	18	22	23	2	14	23	18	18	12	21		16	10	21	11	B

[a] A = random schedule.
B = weekday schedule.

[b] Days sampled for stated period.

Analysis of the frequency distributions shows that for most of the sites the summer season data had the least slope or standard deviation and those of the fall season had the greatest. These findings can be attributed to meteorological conditions. The meteorological conditions during the summer season were more uniform, with only a very few short-term inversions, and more variable in the fall, with more long-term inversions.

On the basis of 1 percent occurrence level (99 percent of samples on figures), results ranged from 182 micrograms per cubic meter at site 432-715 to 1,800 micrograms per cubic meter at site 472-680. This tenfold difference indicates the great variation among residential, commercial, and industrial complexes in the St. Louis area.

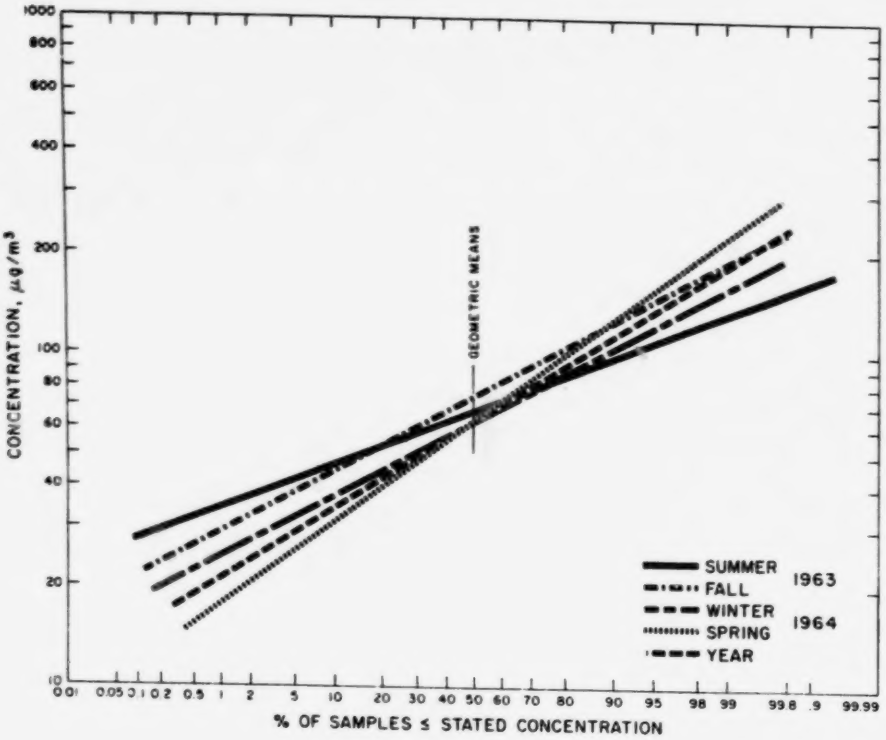


Figure 18. Frequency distribution of suspended particulates measured with high-volume sampler at site No. 432-715.

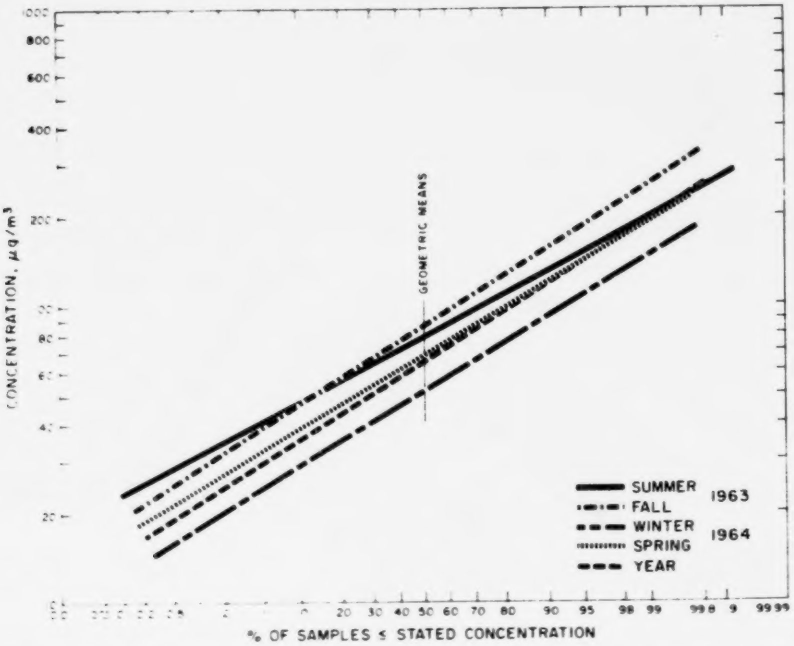


Figure 19. Frequency distribution of suspended particulates measured with high-volume sampler at site No. 438-689.

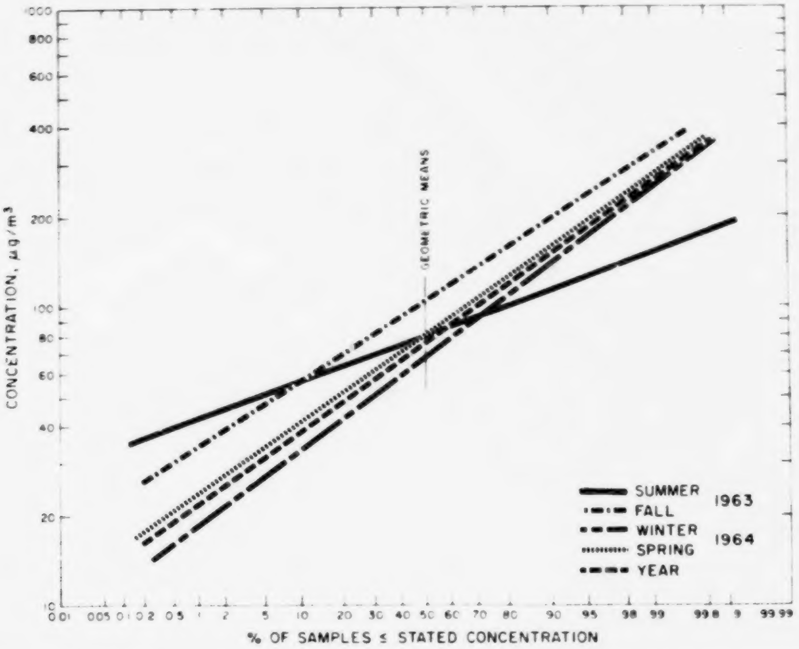


Figure 20. Frequency distribution of suspended particulates measured with high-volume sampler at site No. 449-719.

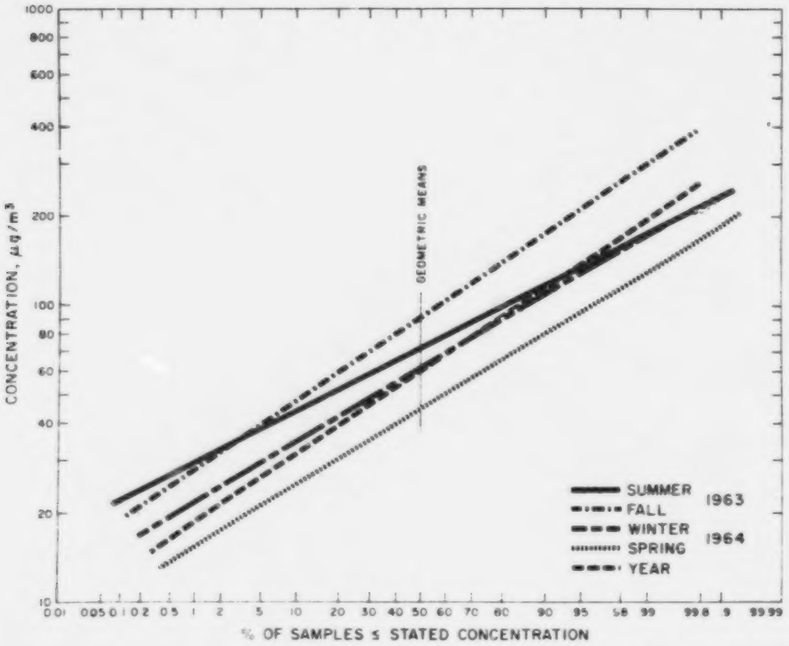


Figure 21. Frequency distribution of suspended particulates measured with high-volume sampler at site No. 468-665.

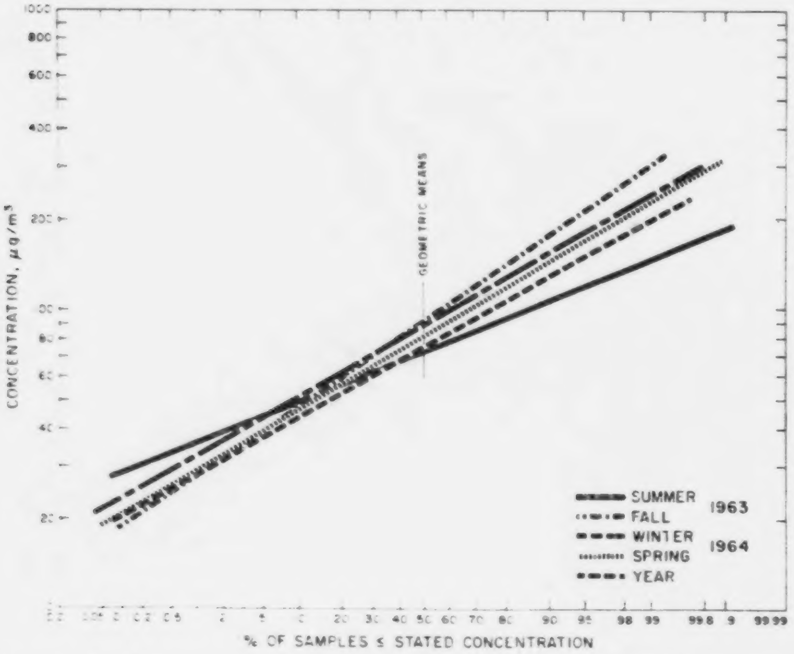


Figure 22. Frequency distribution of suspended particulates measured with high-volume sampler at site No. 469-750.

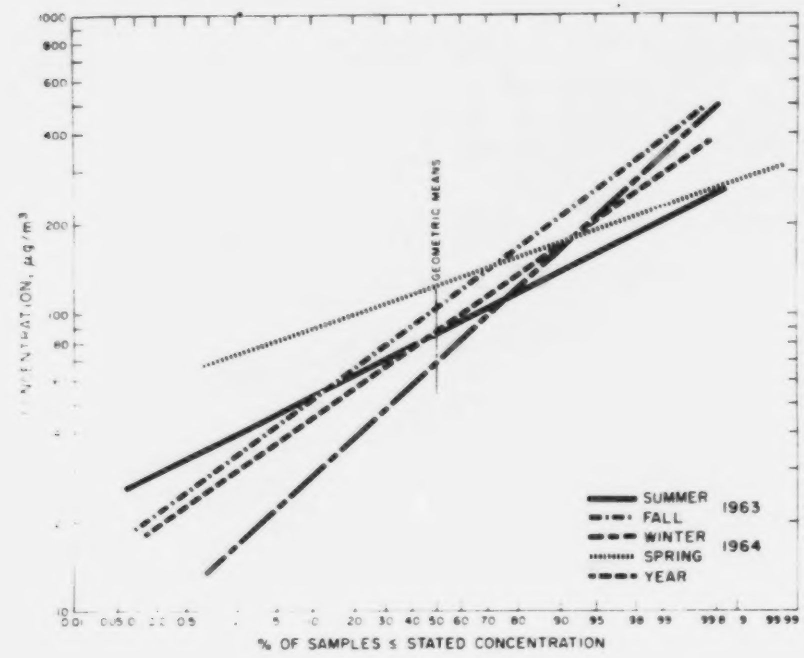


Figure 23. Frequency distribution of suspended particulates measured with high-volume sampler at site No. 470-718.

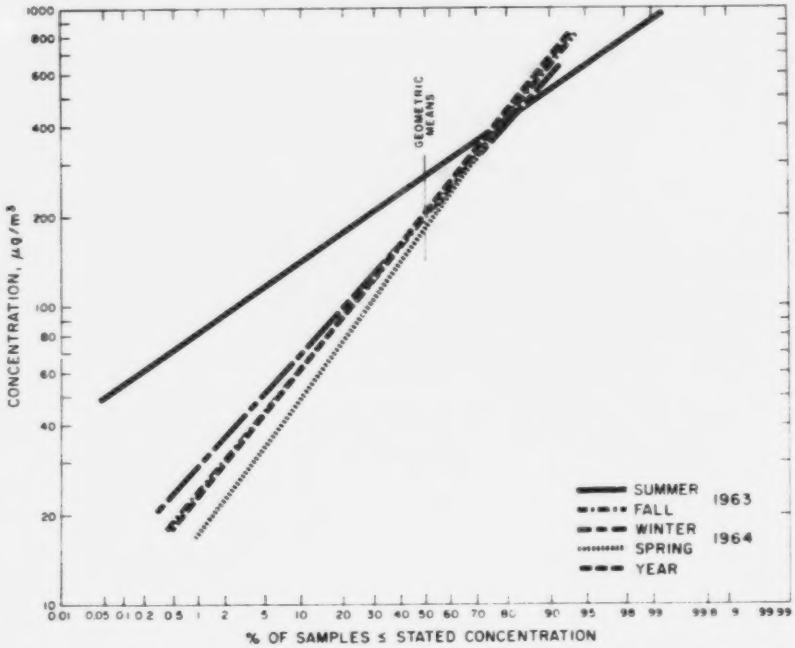


Figure 24. Frequency distribution of suspended particulates measured with high-volume sampler at site No. 472-680.

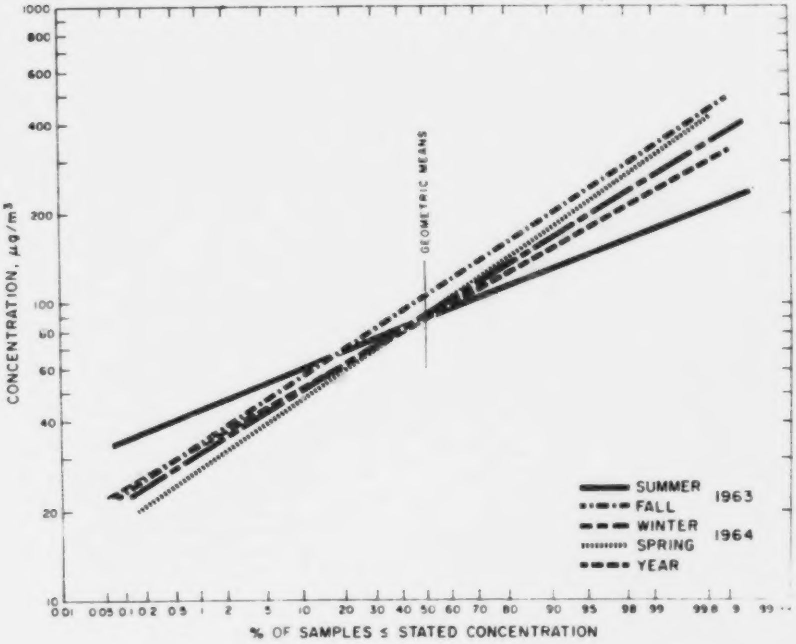


Figure 25. Frequency distribution of suspended particulates measured with high-volume sampler at site No. 481-698.

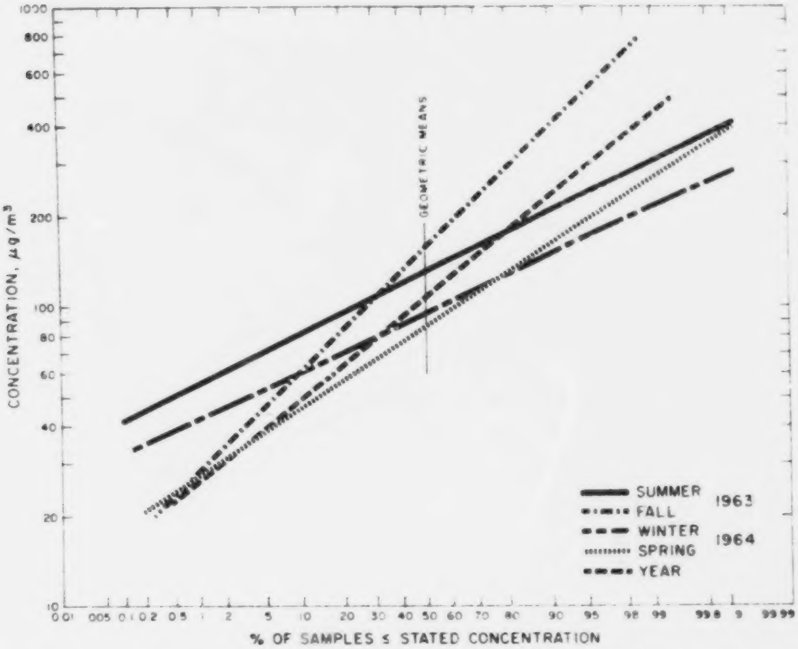


Figure 26. Frequency distribution of suspended particulate measured with high-volume sampler at site No. 489-728.

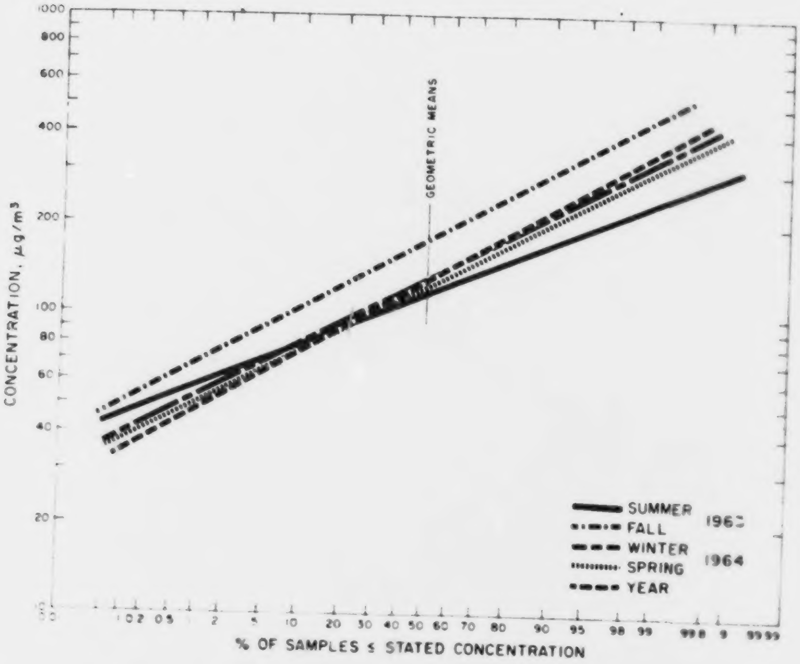


Figure 27. Frequency distribution of suspended particulates measured with high-volume sampler at site No. 490-713.

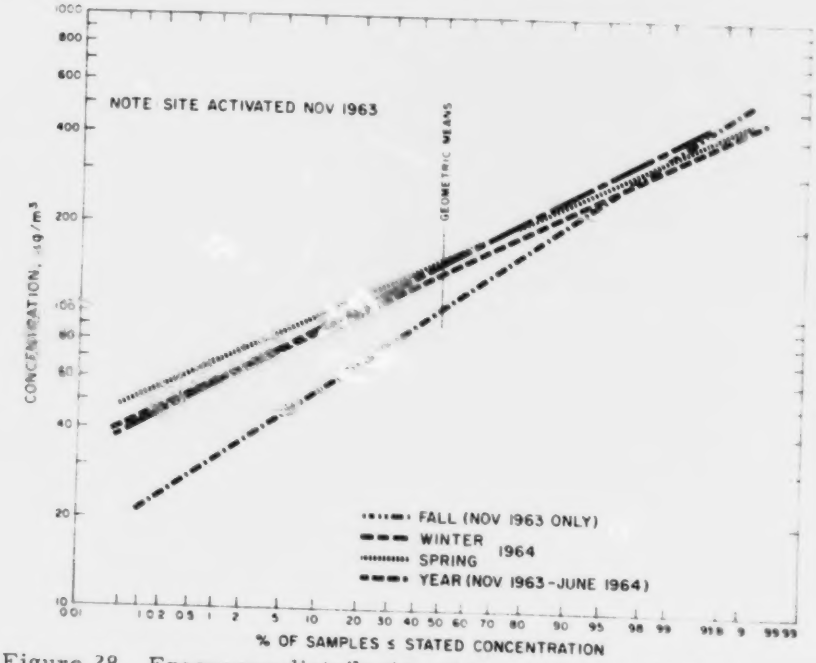


Figure 28. Frequency distribution of suspended particulates measured with high-volume sampler at site No. 495-709.

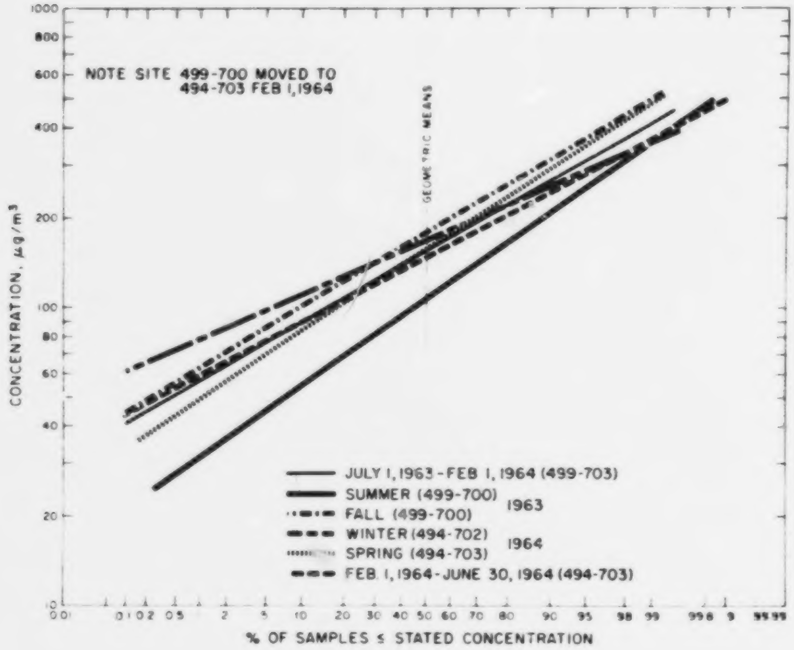


Figure 29. Frequency distribution of suspended particulates measured with high-volume sampler at site No. 499-700 and 494-703.

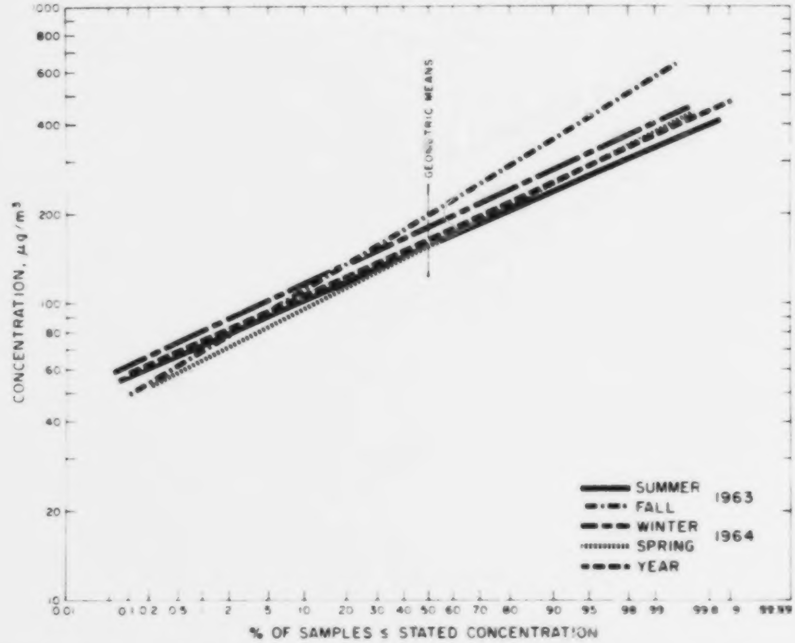


Figure 30. Frequency distribution of suspended particulates measured with high-volume sampler at site No. 501-713.

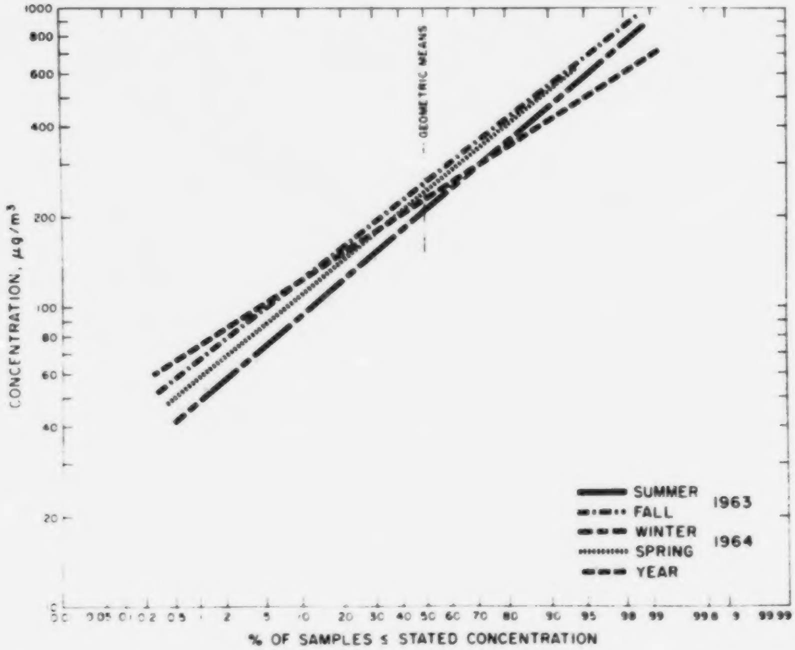


Figure 31. Frequency distribution of suspended particulates measured with high-volume sampler at site No. 505-740.

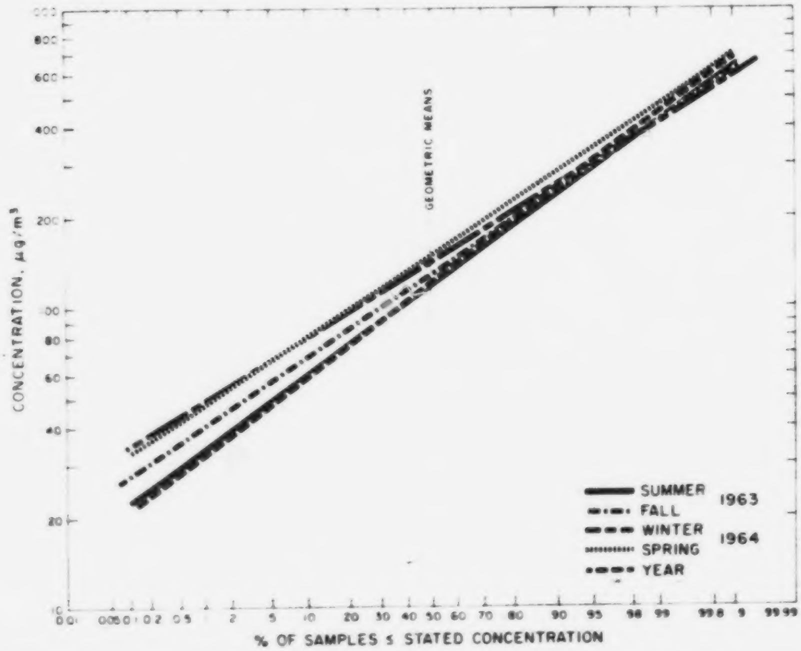


Figure 32. Frequency distribution of suspended particulates measured with high-volume sampler at site No. 520-798.

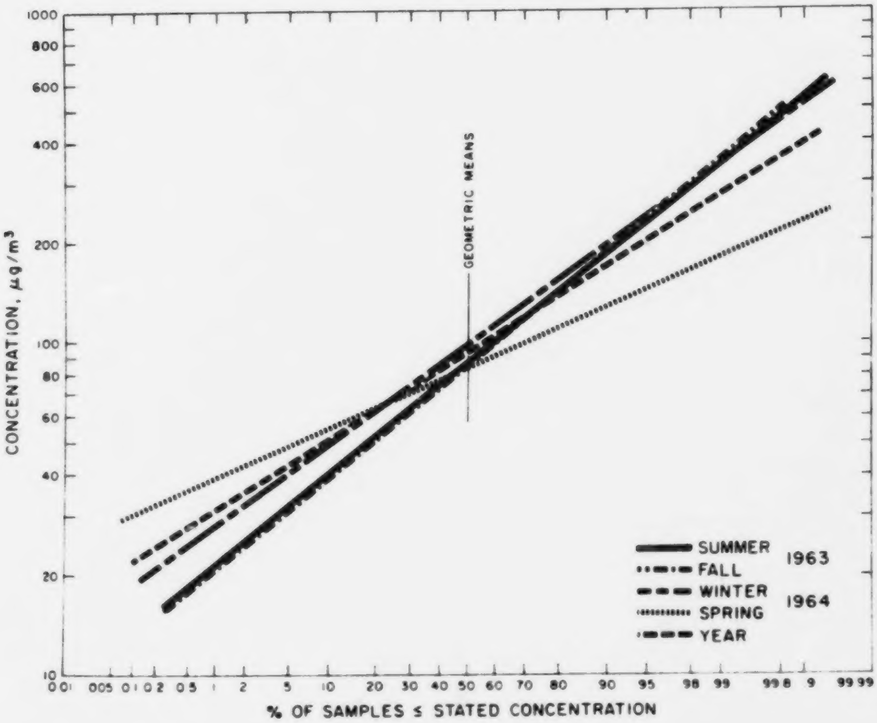


Figure 33. Frequency distribution of suspended particulates measured with high-volume sampler at site No. 534-702.

In addition to the usual statistical approaches used to analyze high-volume air sampler results, a new approach was made to reflect the influence of wind direction on pollution levels. This new approach has been called the "pollution rose" approach since the resulting roses are similar to wind roses. The difference is that pollution levels have been substituted for wind speeds. The results are shown in Figures 34 through 50. When interpreting the pollution roses, one must keep in mind that the wind blows from the end of the arms toward the center of the rose. The length of the arm shows the percent of time the wind was from that direction. The length of the different shadings shows the percent of time each concentration range occurred, and the numbers at the end of the spokes show the arithmetic average concentration for that wind direction. The average concentration for calm conditions is given above each pollution rose. (Example: site 490-713: wind from south 10.8 percent; concentration range: 0-100 µg/m^3, 0.4 percent; 100-150 µg/m^3, 2.0 percent; 150-200 µg/m^3, 3.9 percent; greater than 200 µg/m^3, 4.5 percent; average concentration 186 µg/m^3.) This example indicates that the south wind frequently brings large amounts of suspended particulates as shown by the greater than 200 micrograms per cubic meter range having the highest percent of occurrence.

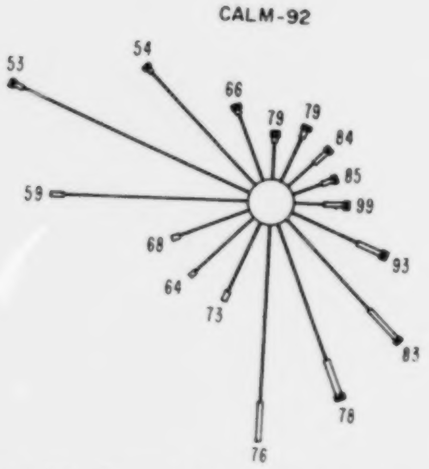


Figure 34. Suspended particulate pollution rose - site No. 432-715 Sept. 1963 - Feb. 1964, 133 samples.

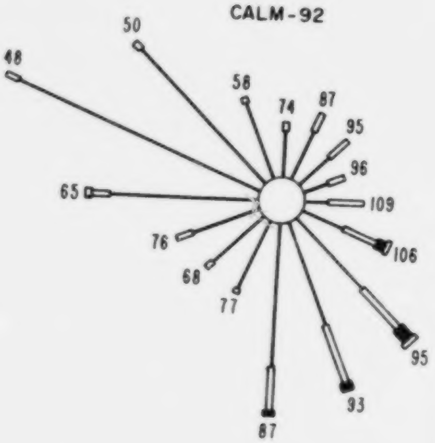
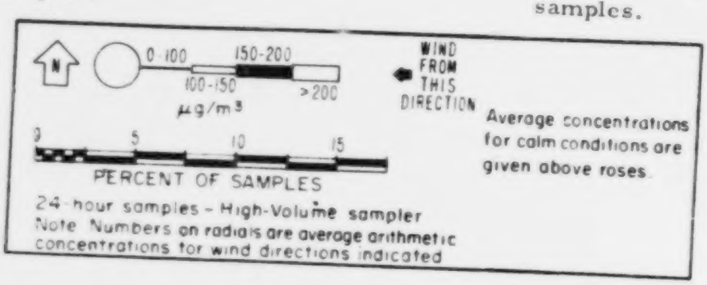


Figure 35. Suspended particulate pollution rose - site No. 438-689 Sept. 1963 - Feb. 1964, 112 samples.


N
0-100
150-200
100-150
>200
μg/m³
WIND FROM THIS DIRECTION
0
5
10
15
PERCENT OF SAMPLES

Average concentrations for calm conditions are given above roses.

24-hour samples - High-Volume sampler

Note Numbers on radials are average arithmetic concentrations for wind directions indicated

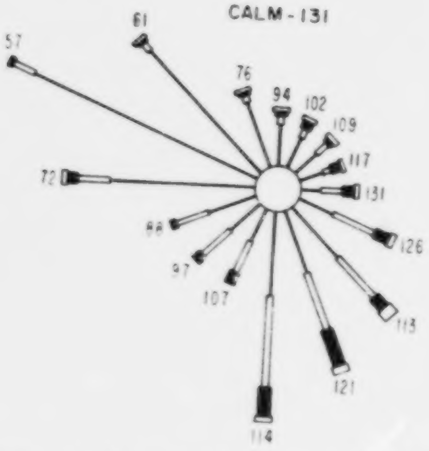


Figure 36. Suspended particulate pollution rose - site No. 449-719 Sept. 1963 - Feb. 1964, 117 samples.

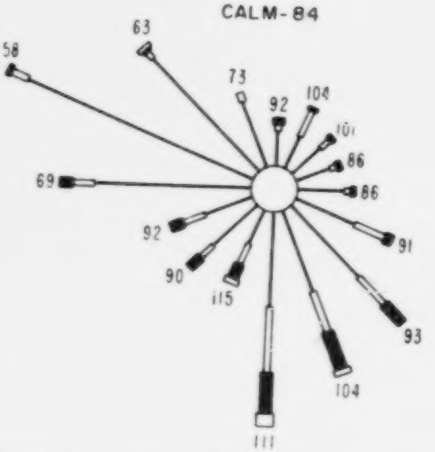


Figure 37. Suspended particulate pollution rose - site No. 468-665 Sept. 1963 - Feb. 1964, 132 samples.

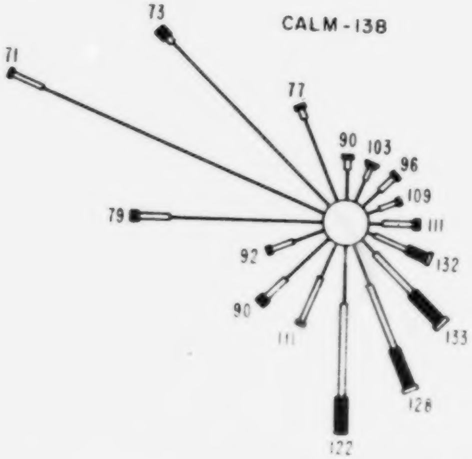


Figure 38. Suspended particulate pollution rose - site No. 469-750 Sept. 1963 - Feb. 1964, 83 samples.

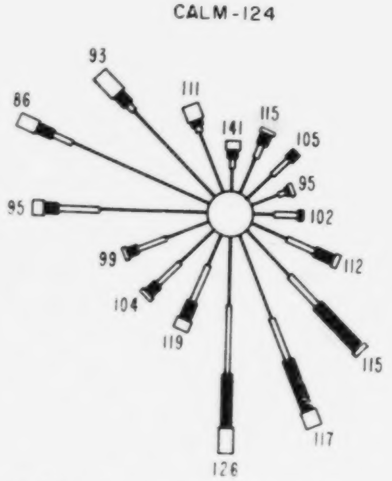
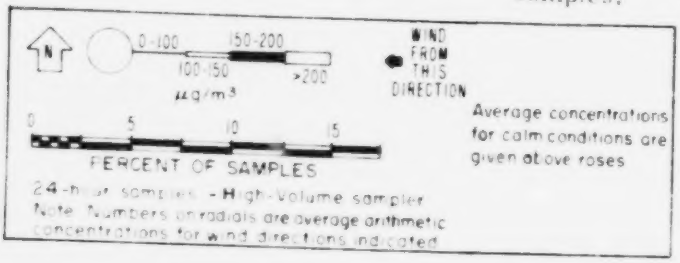


Figure 39. Suspended particulate pollution rose - site No. 470-718 Sept. 1963 - Feb. 1964, 76 samples.


N
0-100
150-200
100-150
>200
µg/m³
WIND FROM THIS DIRECTION
0
5
10
15
PERCENT OF SAMPLES
24-hour samples - High-Volume sampler
Note: Numbers on radials are average arithmetic concentrations for wind directions indicated
Average concentrations for calm conditions are given above roses

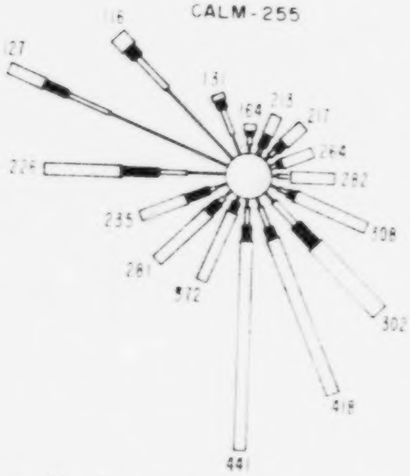


Figure 40. Suspended particulate pollution rose - site No. 472-680 Sept. 1963 - Feb. 1964, 108 samples.

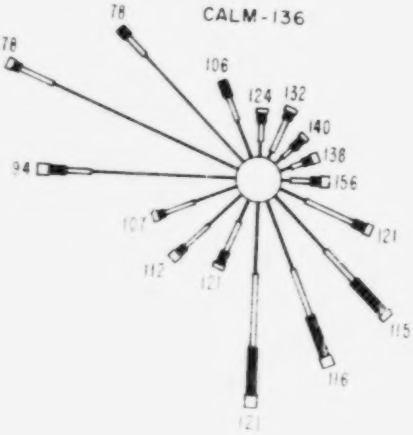


Figure 41. Suspended particulate pollution rose - site No. 481-698 Sept. 1963 - Feb. 1964, 130 samples.

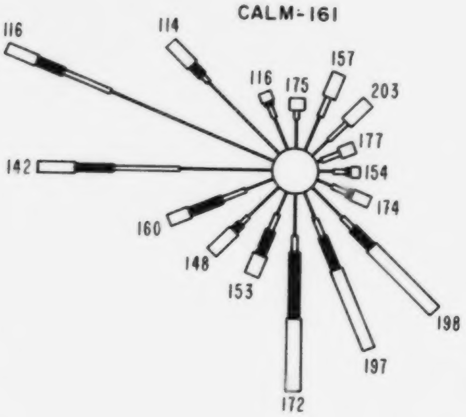


Figure 42. Suspended particulate pollution rose - site No. 489-728 Sept. 1963 - Feb. 1964, 60 samples.

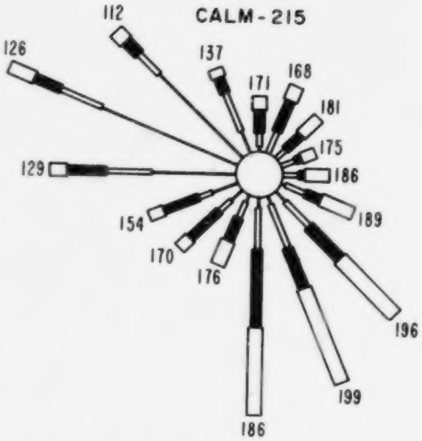
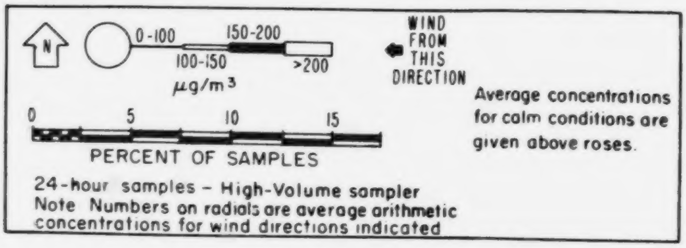


Figure 43. Suspended particulate pollution rose - site No. 490-713 Sept. 1963 - Feb. 1964, 111 samples.


N
0-100
150-200
100-150
>200
μg/m³
WIND FROM THIS DIRECTION
0
5
10
15
PERCENT OF SAMPLES

Average concentrations for calm conditions are given above roses.

24-hour samples - High-Volume sampler
Note Numbers on radials are average arithmetic concentrations for wind directions indicated

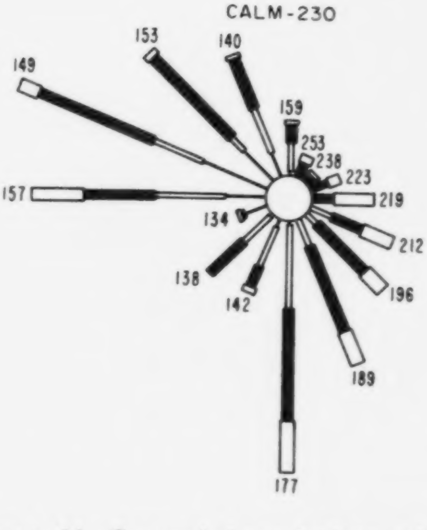


Figure 44. Suspended particulate pollution rose - site No. 494-703 Jan. 1964 - Feb. 1964, 31 samples.

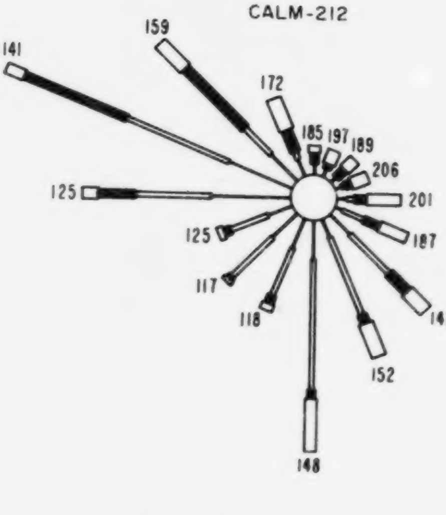


Figure 45. Suspended particulate pollution rose - site No. 495-709 Nov. 1963 - Feb. 1964, 66 samples.

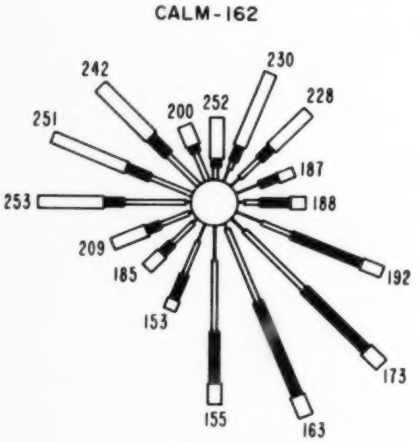


Figure 46. Suspended particulate pollution rose - site No. 499-700 Sept. 1963 - Feb. 1964, 49 samples.

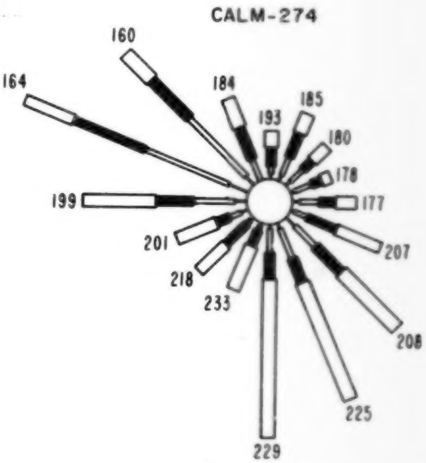
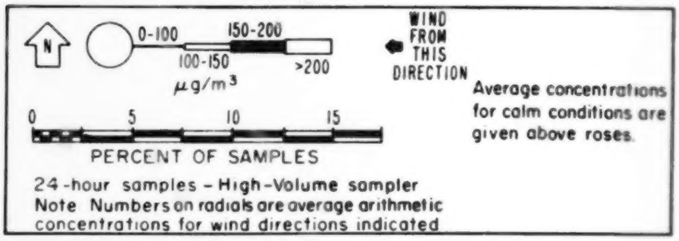


Figure 47. Suspended particulate pollution rose - site No. 501-713 Sept. 1963 - Feb. 1964, 108 samples.


N
0-100
150-200
100-150
>200
µg/m³
WIND FROM THIS DIRECTION
0
5
10
15
PERCENT OF SAMPLES

Average concentrations for calm conditions are given above roses.

24-hour samples - High-Volume sampler

Note Numbers on radials are average arithmetic concentrations for wind directions indicated

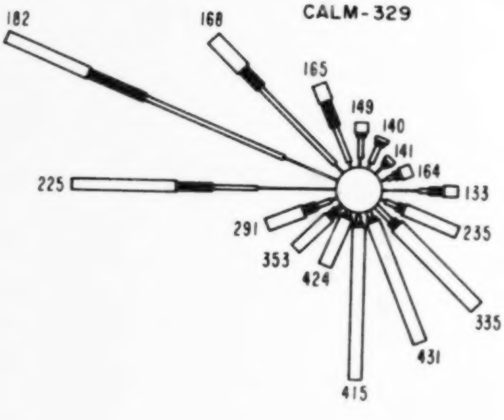


Figure 48. Suspended particulate pollution rose - site No. 505-740 Nov. 1963 - Feb. 1964, 66 samples.

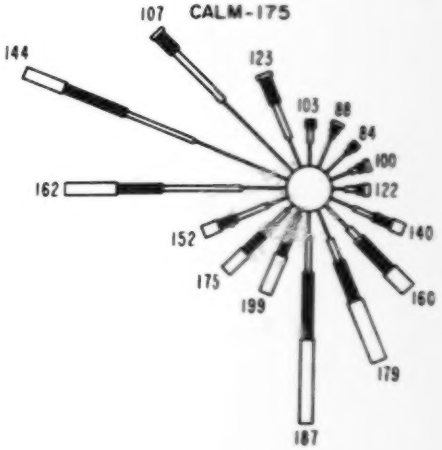


Figure 49. Suspended particulate pollution rose - site No. 520-798 Sept. 1963 - Feb. 1964, 114 samples.

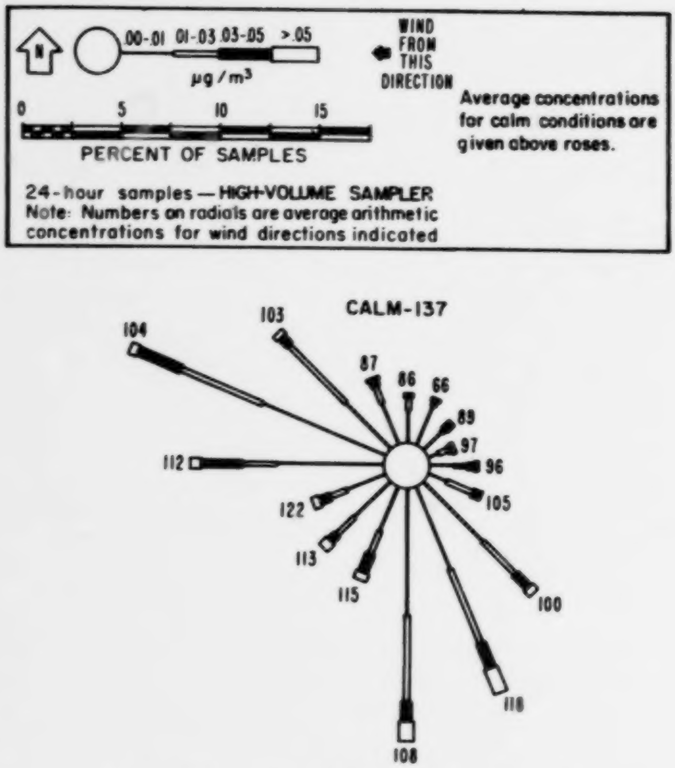


Figure 50. Suspended particulate pollution rose - site No. 534-702 Sept. 1963 - Feb. 1964, 72 samples.

The results from September 1963 through February 1964 were used for the roses because the weekday sampling schedule in effect then provided a greater number of samples and thus greater reliability of pollution rose data. The meteorological data were obtained from Lambert Field (coordinates 440-760). Although the meteorological data were collected several miles from some of the sampling sites, comparison of these data with those collected at different levels on the KMOX-TV tower (coordinates 491-716) indicated that the Lambert Field data were the best to use for pollution rose preparation. The tower data, however, reported in part in Volume V, Meteorology and Topography, and a report by Dr. George Arnold[15] indicate the presence of a heat island influence on air circulation. The KMOX-TV tower data, therefore, should be used to help make detailed interpretations of results in the St. Louis central business district and East St. Louis city areas.

The pollution roses show the west to northwest and south to southeast sectors had the most frequently occurring winds. Sites 432-715, 438-689, and 449-719 had few occurrences of suspended particulates in high ranges, but most of the pollutant came from the eastern sectors as indicated by the higher-direction averages. Beginning with site 468-665 and moving toward the City of St. Louis, the percent of occurrence of suspended particulates in high ranges increased very sharply and remained high for the sites in Illinois. Measurements at site 534-702, the most easterly site, decreased to relatively few occurrences of upper-range suspended particulates. The roses for sites 472-680, 499-700, and 505-740, which were close to large sources, clearly indicate the direction of the major sources from the sampling sites. The other roses indicate directions of the winds that bring the most pollution to each site, but the variations for these are not as obvious as for the first three sites.

To indicate the importance of directional influence on suspended particulate pollutants and to provide a guide for design of the pollution reduction plan, a directional analysis was made using data pertaining to the maximum directions as shown on the pollution roses. These data appear on the pollution rose printouts by 10 percentiles. An example of a resulting frequency distribution and percent reductions needed to reach an air quality goal of 75 micrograms per cubic meter is shown in Figure 51 for sampling site 495-709, which had a maximum pollution level of 201 micrograms per cubic meter from the east. Figures 52 and 53 show the direction of maximum pollution influence and percent reductions needed to reach a 75 microgram-per-cubic-meter goal at all high-volume sampler stations for both geometric mean and 99th percentile conditions.

The method of making the percent source strength reduction calculation is that developed by Larsen during work in Los Angeles.[11] Here, Larsen's method is applied to single directions rather than to the sampling site station as a unit. The directions reported are considered quite significant and the percent reductions, somewhat less significant because of a number of factors. First, the method of computing pollution rose data tends to distribute some high values to the wind directions on either side of the highest value direction. Second, the distance to the major sources in that direction are not considered, and, therefore, the diffusion that results along the trajectory of the pollutants is not adequately considered. Third, the winds carrying pollutants have a tendency to meander so that pollutants from a single source are brought to the station from a sector rather than from a specific direction. This dilution tends to reduce the effects of the source on the station when directions are considered. The method is thought to be conservative and tends to underestimate the percent reduction needed. It was also applied conservatively by selecting the highest known station value as being the 99th percentile value in those instances where the plotted 99th percentile was much higher. The air quality goals of 75 and 200 micrograms per cubic meter for the geometric mean and 99th percentile are used here as examples only. Background

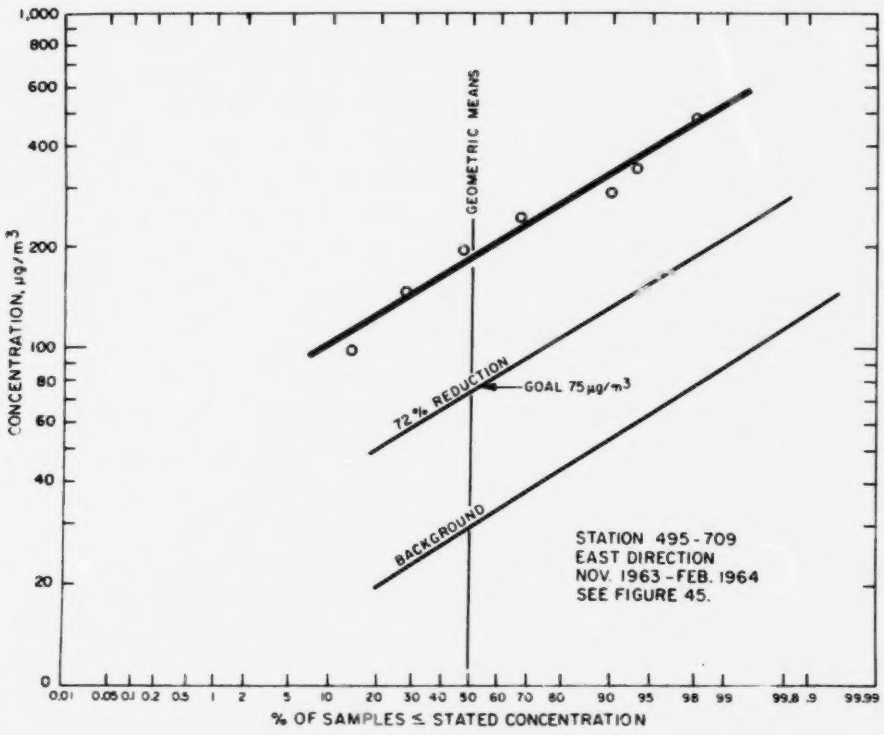
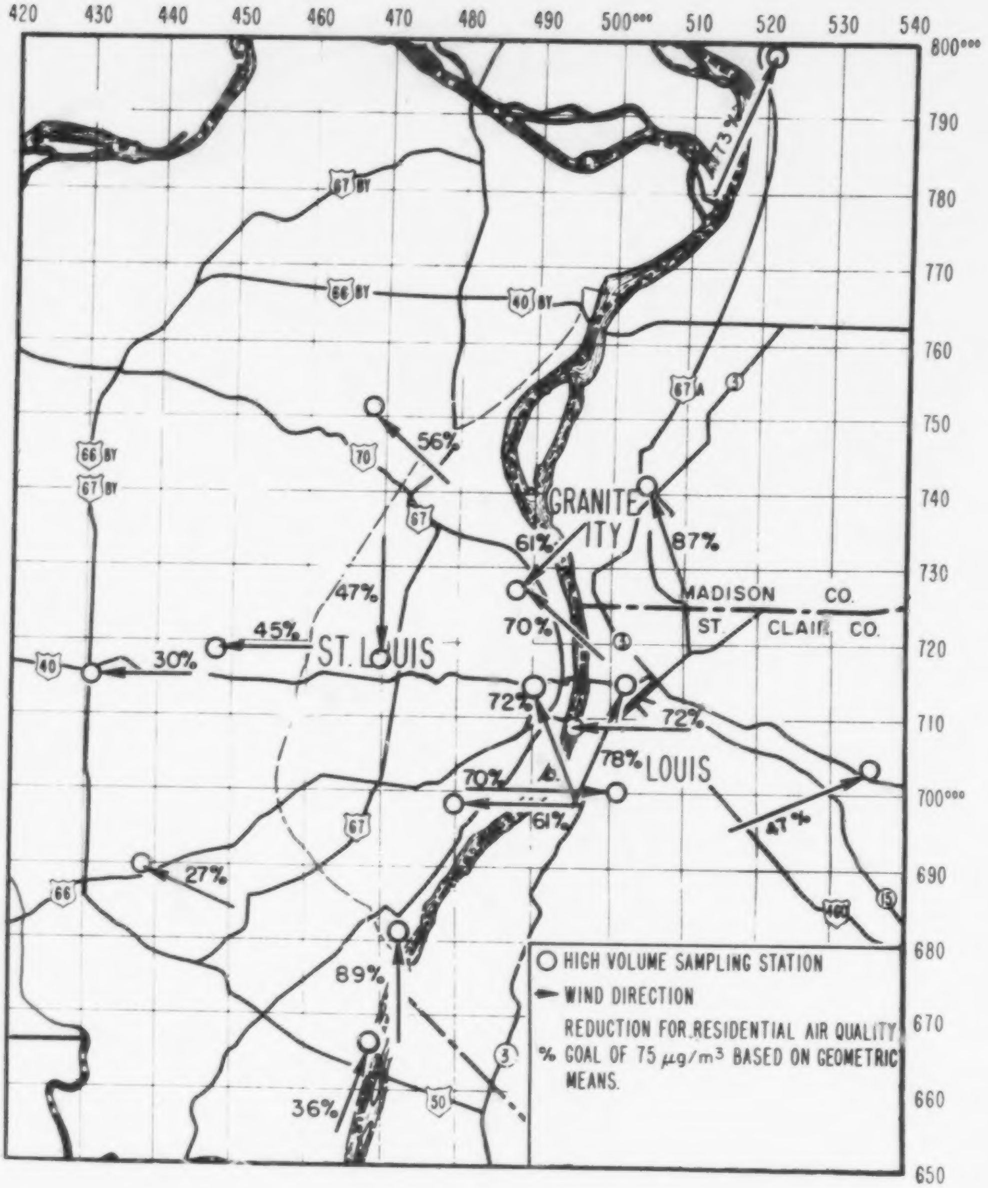


Figure 51. Frequency distribution of suspended particulates measured with high-volume sampler - maximum direction analysis.

levels of 30 and 91 micrograms per cubic meter, geometric mean, and 99th percentiles, respectively, were used.

The maps in Figures 52 and 53 show that the central part of the Study area, in general, has a considerable effect on the pollution levels in the outlying areas. The source areas of major importance are indicated as being south of East St. Louis and in a southerly direction from Granite City. The area south of Jefferson Barracks shows the influence of downriver sources or the influence of river topography on transport of pollutants. Both the geometric means and 99th percentiles show essentially the same results with emission reductions of 10 to 30 percent called for in the outlying areas and 60 to 96 percent in the central areas.

Another approach to interpreting the high-volume air sampler data was to correlate it with Pasquill's stability classification as described by Turner.[12] The stability classes were described previously in the Measurement Methods section of this Report. The results are given in Table 15. Wind speed appears to be the meteorological factor of primary importance, since 11 stations indicated a high particulate loading with low wind speeds and low particulate loading with high wind


420
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440
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460
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480
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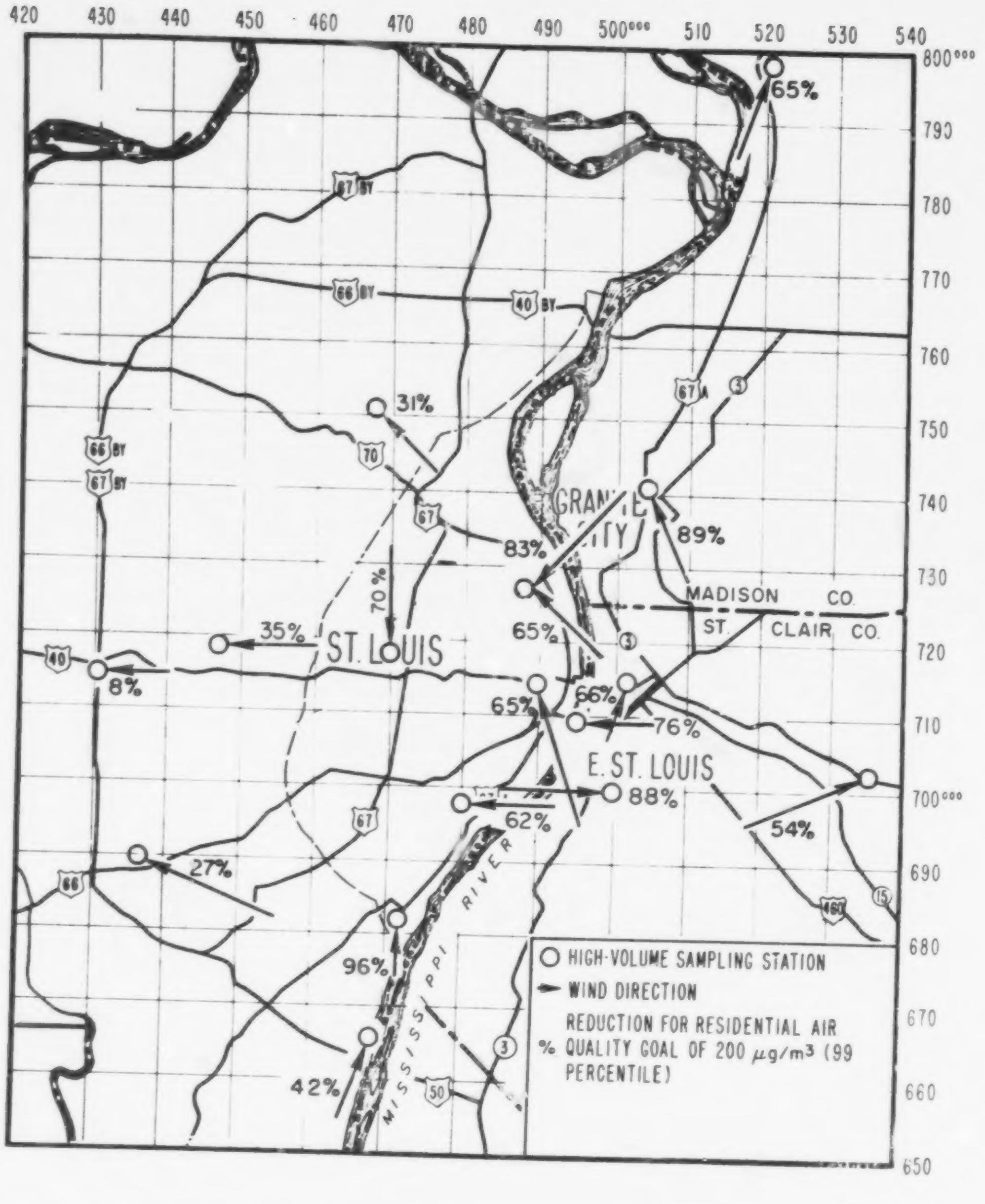
500000
510
520
530
540
800000
790
780
770
760
750
740
730
720
710
700000
690
680
670
660
650
73%
56%
GRANITE CITY
61%
87%
47%
MADISON CO.
ST. CLAIR CO.
70%
45%
ST. LOUIS
30%
72%
72%
78%
LOUIS
70%
61%
47%
27%
89%
36%
67 BY
66 BY
40 BY
66 BY
67 BY
70
67
40
67
66
67A
3
3
50
460
15
○ HIGH VOLUME SAMPLING STATION
WIND DIRECTION
% REDUCTION FOR RESIDENTIAL AIR QUALITY GOAL OF 75 μg/m³ BASED ON GEOMETRIC MEANS.

Figure 52. Directions of maximum influence on high-volume sampler stations and direction-percent reductions (geometric means).


420
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490
500000
510
520
530
540
800000
790
780
770
760
750
740
730
720
710
700000
690
680
670
660
650
65%
31%
83%
89%
70%
65%
35%
8%
66%
65%
76%
88%
62%
54%
27%
96%
42%
ST. LOUIS
E. ST. LOUIS
GRANITE CITY
MADISON CO.
ST. CLAIR CO.
MISSISSIPPI RIVER
67 BY
66 BY
40 BY
66 BY
67 BY
70
67
67A
3
40
67
66
460
15
3
50
HIGH-VOLUME SAMPLING STATION
WIND DIRECTION
% REDUCTION FOR RESIDENTIAL AIR QUALITY GOAL OF 200 μg/m³ (99 PERCENTILE)

Figure 53. Directions of maximum influence on high-volume sampler stations and direction-percent reductions (99 percentile).

Table 15. AVERAGE SUSPENDED PARTICULATES BY HIGH-VOLUME SAMPLER FOR FIVE ATMOSPHERIC STABILITY CLASSES, JULY 1963 - JUNE 1964 ($\mu g/m^3$)

Site coordinates	Atmospheric stability class[a]				
	1	2	3	4	5,6,7
432-715	80.000	93.775	75.590	61.984	76.502
438-689	109.889	97.747	84.873	63.119	80.183
449-719	102.158	101.964	94.270	75.547	90.270
468-665	87.684	84.000	74.845	59.912	73.872
469-750	95.846	95.325	82.729	76.891	86.423
470-718	119.000	110.929	110.075	93.264	97.459
472-680	229.667	281.867	302.584	314.027	289.152
481-698	120.556	119.516	109.044	89.284	103.218
489-728	191.857	174.823	133.980	106.094	139.007
490-713	196.625	180.413	149.623	130.909	144.576
494-703[b]	-	154.000	147.967	162.712	147.891
495-709[c]	152.818	157.276	148.673	139.655	150.823
499-700[d]	-	173.571	147.803	176.863	159.299
501-713	199.389	219.179	195.585	157.835	194.442
505-740[c]	261.357	257.932	249.082	240.280	255.036
520-798	123.167	129.396	125.356	140.929	128.025
534-702	148.000	130.939	105.991	94.830	114.821

[a] 1 = extremely unstable.
2 = unstable.
3 = slightly unstable.
4 = neutral.
5,6,7 = slightly stable, stable, and extremely stable.

[b] January 1964 - July 1964.

[c] November 1963 - July 1964.

[d] July 1963 - December 1963.

[e] November 1963 - July 1964.

speeds, whereas only six indicated the reverse relationship. In view of the overriding importance of wind speed, attempts should be made to determine the mathematical formulas expressing this relationship for each pollutant.

Analyses were made of some of the high-volume filter samples for metals and organic matter content. The results are given in Tables 16 and 17 and Figures 54 and 55. Also included are the results from the St. Louis and East St. Louis NASN sites and the Midwest averages. The samples were selected on the basis of the meteorological conditions conducive to high air pollution and the wind being mostly from one direction. Samples were also selected so that the eight major wind directions were represented. The maps in Figures 54 and 55 show the wind directions associated with levels of organic and metal particulates considered worth reporting for comparison purposes. The bases for comparison are given at the end of Table 16. They are the NASN averages for 1957 through 1961 for the nation, Midwest, and St. Louis. The following numerical values were selected:

Particulate	Concentration, $\mu g/m^3$	Particulate	Concentration, $\mu g/m^3$
Organic	15.0	Vanadium	0.015
Beryllium	Any	Zinc	0.75
Manganese	0.01	Chromium	0.05
Lead	1.0	Nickel	0.030
Tin	0.06	Molybdenum	0.02
Iron	3.0	Cobalt	0.003
Copper	0.08	Bismuth	Any
Titanium	0.08	Cadmium	0.030
Antimony	Any		

The maps show the areas along the river and near industrial areas to be the most polluted with metal and organic particulates. Nearly all of the stations showed lead occurring in above-average concentrations.

The NASN has had high-volume samplers operating in both St. Louis and East St. Louis. The St. Louis station, located at coordinates 489-714, collected data every year from 1957 through 1963. The East St. Louis station, located at coordinates 501-713, provided data for the years 1958, 1961, and 1963. These data are summarized in Figure 56 and compared with the national averages for each year in Figure 57. The East St. Louis results were higher than the St. Louis results, and both were higher than the national average. With the exception of an increase in 1959, suspended particulates have decreased gradually in St. Louis since 1957, as did the national average. The 1963 East St. Louis value was lower than that for 1958, but a sharp increase from 1961 to 1963 indicates an increase in pollution.

Table 16. METAL AND ORGANIC CONTENT OF SELECTED HIGH-VOLUME FILTERS, 1963

Site coordinates	Wind dir	Date	Concentration, µg/m³																	
			Partic	Organic	Be	Mn	Pb	Sn	Fe	Cu	Ti		Zn	Cr	Ni	Mo	Co	Bi	Cd	Sb
432-715	SW	6/6/63	72	2.6	0.0000	0.02	0.4	0.00	0.7	0.04	0.01	0.013	0.00	0.000	0.026	0.00	0.000	0.000	0.006	0.000
	SE	6/24/63	72	4.0	0.0000	0.03	0.7	0.01	0.8	0.03	0.03	0.005	0.00	0.008	0.019	0.00	0.000	0.000	0.028	0.000
	NW	10/28/63	56	3.1	0.0000	0.02	0.3	0.00	0.5	0.01	0.01	0.004	0.00	0.000	0.020	0.00	0.000	0.000	0.000	0.000
438-689	E	8/26/63	136	5.9	0.0000	0.07	0.5	0.02	1.1	0.05	0.03	0.010	0.68	0.009	0.024	0.00	0.000	0.000	0.009	0.000
	NW	10/28/63	50	2.3	0.0000	0.02	0.1	0.00	0.3	0.02	0.00	0.000	0.00	0.000	0.008	0.00	0.000	0.000	0.000	0.000
449-719	SE	6/24/63	71	3.4	0.0000	0.04	0.6	0.00	1.1	0.04	0.02	0.003	0.00	0.005	0.011	0.00	0.000	0.000	0.000	0.000
	NE	7/8/63	70	3.3	0.0000	0.05	0.3	0.03	0.8	0.02	0.02	0.013	0.60	0.006	0.027	0.00	0.000	0.000	0.000	0.000
	SE	10/14/63	242	9.3	0.0000	0.15	2.0	0.02	2.4	0.08	0.05	0.016	0.00	0.011	0.034	0.00	0.000	0.000	0.000	0.000
	NW	10/28/63	83	8.5	0.0000	0.03	0.1	0.00	0.4	0.01	0.01	0.007	0.00	0.000	0.026	0.00	0.000	0.000	0.000	0.000
468-665	SW	6/6/63	79	2.2	0.0000	0.01	0.1	0.00	0.3	0.03	0.01	0.000	0.00	0.007	0.008	0.00	0.000	0.000	0.022	0.000
	N	8/14/63	102	4.4	0.0000	0.02	0.3	0.01	0.4	0.03	0.01	0.000	0.35	0.006	0.007	0.00	0.000	0.000	0.000	0.000
	NW	10/28/63	74	1.9	0.0000	0.02	0.2	0.00	0.3	0.01	0.02	0.017	0.00	0.000	0.015	0.00	0.000	0.000	0.000	0.000
469-750	SW	6/6/63	68	4.3	0.0000	0.04	0.6	0.00	0.6	0.04	0.01	0.000	0.00	0.000	0.000	0.00	0.000	0.000	0.000	0.000
	SE	6/24/63	96	3.7	0.0000	0.02	0.3	0.03	0.4	0.04	0.01	0.007	0.25	0.000	0.012	0.00	0.000	0.000	0.000	0.000
	NE	7/6/63	61	2.4	0.0000	0.03	0.5	0.02	0.6	0.12	0.01	0.004	0.61	0.067	0.000	0.00	0.000	0.000	0.000	0.000
	NW	10/26/63	69	5.5	0.0000	0.03	0.7	0.03	0.6	0.02	0.01	0.000	0.00	0.007	0.000	0.00	0.000	0.000	0.000	0.000
	S	11/7/63	229	25.4	0.0000	0.11	3.8	0.02	2.0	0.08	0.05	0.024	0.78	0.013	0.036	0.01	0.000	0.000	0.000	0.000
470-718	SW	6/25/63	85	3.7	0.0000	0.06	1.7	0.01	0.8	0.02	0.01	0.000	0.24	0.005	0.007	0.00	0.000	0.000	0.000	0.000
	NE	7/8/63	92	5.7	0.0000	0.04	0.5	0.01	0.8	0.02	0.02	0.002	0.74	0.007	0.015	0.00	0.000	0.000	0.000	0.000
470-718	S	7/16/63	175	9.2	0.0000	0.07	1.3	0.09	1.0	0.05	0.02	0.000	1.70	0.009	0.015	0.00	0.000	0.000	0.009	0.000

Table 16. (Cont'd) METAL AND ORGANIC CONTENT OF SELECTED HIGH-VOLUME FILTERS, 1963

Site coordinates	Wind dir	Date	Concentration, $\mu g/m^3$																	
			Partic	Organic	Be	Mn	Pb	Sn	Fe	Cu	Ti	V	Zn	Cr	Ni	Mo	Co	Bi	Cd	Sb
472-680	N	5/10/63	261	10.5	0.0000	0.05	0.4	0.01	1.1	0.02	0.04	0.003	1.90	0.000	0.000	0.00	0.030	0.000	0.000	0.000
	S	4/15/63	1576	4.9	0.0000	0.03	0.1	0.00	19.0	0.11	1.00	[illegible]	1.30	0.020	0.092	0.01	0.050	0.000	0.000	0.000
	SW	6/6/63	189	1.2	0.0000	0.00	0.1	0.00	2.6	0.04	0.27	0.000	0.00	0.006	0.000	0.00	0.000	0.000	0.018	0.000
	SE	6/24/63	468	2.5	0.0000	0.05	0.2	0.00	6.3	0.05	0.43	0.010	0.00	0.000	0.056	0.01	0.011	0.000	0.000	0.000
	NE	7/8/63	183	5.6	0.0000	0.09	0.8	0.01	2.3	0.04	0.04	0.010	1.50	0.000	0.014	0.00	0.000	0.000	0.000	0.000
481-698	SE	6/24/63	92	6.3	0.0000	0.02	0.2	0.00	0.4	0.10	0.02	0.002	0.00	0.000	0.009	0.00	0.000	.000	0.000	0.000
	NE	7/8/63	106	3.5	0.0000	0 06	0.5	0.01	1.7	0.08	0.01	0.000	1.80	0.008	0.013	0.00	0.000	0.000	0.000	0.000
	NE	10/17/63	217	7.4	0.0000	0.13	1.0	0.01	1.7	0.05	0.03	0.000	6.80	0.010	0.013	0.00	0.000	0.000	0.012	0.000
	E	10/13/63	123	4.8	0.0000	0.05	0.6	0.02	0.9	0.10	0.01	0.000	0.54	0.006	0.006	0.03	0.000	0.000	0.000	0.000
	NW	10/28/63	84	3.8	0.0000	0.10	0.8	0.03	0.5	0.06	0.01	0.000	0.71	0.006	0.010	0.000	0.000	0.000	0.000	0.000
489-728	E	[illegible]/23/63	132	5.9	0.0000	0.05	0.5	0.00	0.6	0.02	0.01	[illegible]	0.91	0.000	[illegible]	0.00	0.000	0.000	0.013	0.000
	SE	6/24/63	126	3.1	0.0000	0.04	0.8	0.06	0.7	0.63	0.02	0.020	3.10	0.011	0.033	0.01	0.000	0.000	0.026	0.000
	NE	7/8/63[a] (72-hr sam),	39	1.6	0.0000	0.02	0.2	0.01	0.4	0.01	0.01	0.004	0.31	0.002	0.014	0.00	0.000	0.000	0.000	0.000
490-715	SW	6/6/63	109	4.4	0.0000	0.03	0.4	0.02	0.9	0.16	0.02	0.014	3.55	0.007	0.027	0.00	0.000	0.000	0.012	0.000
	SE	6/24/63	121	3.9	0.0000	0.05	0.6	0.04	1.2	0.39	0.02	0.006	2.60	0.015	0.017	0.00	0.000	0.000	0.020	0.000
	NE	7/9/63	134	4.8	0.0000	0.13	0.5	0.03	1.5	0.04	0.02	0.010	2.80	0.012	0.024	0.01	0.000	0.000	0.000	0.000
	SE	7/11/63	191	4.8	0.0000	0.08	0.6	0.01	2.1	0.13	0.03	0.007	3.60	0.011	0.013	0.01	0.000	0.000	0.009	0.000
	E	9/9/63	221	10.3	0.0000	0.08	1.0	0.01	2.1	0.10	0.03	0.017	1.70	0.017	0.030	0.01	0.000	0.000	0.027	0.000
	W	11/22/63	435	2.7	0.0000	0.02	0.4	0.00	0.4	0.02	0.01	0.005	0.00	0.000	0.000	0.00	0.000	0.000	0.000	0.000
	SE	9/17/63	229	21.8	0.0000	0.15	5.2	0.02	4.[illegible]	0.18	0.03	0.017	12.00	0.026	0.040	0.01	0.000	0.001	0.250	0.000
	SE	9/23/63	212	8.0	0.0000	0.08	1.1	0.00	2.0	0.06	0.03	0.014	7.80	0.013	0.036	0.00	0.000	0.000	0.013	0.000
	S	11/15/63	160	9.3	0.000	0.08	[illegible]	0.01	1.4	[illegible]	[illegible]	0.025	0.00	0.015	0.032	0.00	0.000	0.000	0.000	0.000
499-700	N	5/10/63	246	4.0	0.0000	0.07	0.6	0.03	1.7	0.11	0.02	0.000	[illegible]	0.011	0.023	0.01	0.000	0.000	0.021	0.000
	SW	6/6/63	87	2.1	0.0000	0.03	0.3	0.00	0.6	0.06	0.01	0.000	0.00	0.000	0.008	0.00	0.000	0.000	0.041	0.000
	SE	6/24/63	85	1.4	0.0000	0.02	[illegible]	0.00	[illegible]	0.08	0.01	0.004	0.00	0.000	0.008	0.00	0.000	0.000	0.000	0.000
	W	6/27/63	138	4.1	0.0000	0.07	2.2	0.04	1.1	0.20	0.02	0.000	4.00	0.007	0.015	0.00	0.000	0.100	0.190	0.000

Table 16. (Cont'd) METAL AND ORGANIC CONTENT OF SELECTED HIGH-VOLUME FILTERS, 1963

Site coordinates	Wind dir	Date	Concentration, µg/m³																	
			Partic	Organic	Be	Mn	Pb	Sn	Fe	Cu	Ti	V	Zn	Cr	Ni	Mo	Co	Bi	Cd	Sb
499-700	SE	5/23/63	240	7.8	0.0000	0.03	5.2	0.58	[illegible]	[illegible]	0.01	0.000	18.00	0.013	0.024	0.01	0.000	0.004	0.640	0.000
	E	5/30/63	204	10.8	0.0000	0.20	1.7	0.34	[illegible]	[illegible]	0.02	0.000	15.00	0.015	0.028	0.00	0.000	0.00	0.041	0.000
501-713	S	4/15/63	188	6.2	0.000	0.06	0.4	0.21	2.5	[illegible]	0.03	0.006	1.30	0.006	0.016	0.00	0.000	0.000	0.000	0.000
	SW	6/6/63	148	5.7	0.0000	0.04	0.8	0.01	2.	[illegible]	0.03	0.004	0.66	0.006	0.011	0.00	0.000	0.000	0.056	0.00
	NE	7/8/63	155	10.2	0.0000	0.07	0.3	0.01	2.0	0.05	0.01	0.006	0.56	0.007	0.012	0.00	0.000	0.000	0.000	0.000
	NW	7/13/63	427	5.1	0.0000	0.01	0.4	0.00	[illegible]	[illegible]	0.00	0.000	0.00	0.006	0.000	0.00	0.000	0.000	0.000	0.000
	N	8/14/63	251	23.9	0.0000	0.15	1.8	0.34	3.4	0.26	0.00	0.003	4.70	0.013	0.019	0.00	0.000	0.000	0.054	0.000
520-798	SW	4/16/63	257	5.8	0.0000	0.07	0.4	0.01	2.8	0.06	0.03	0.000	2.40	0.007	0.019	0.00	0.000	0.000	0.009	0.000
	NW	4/22/63	169	1.6	0.0000	0.07	0.4	0.01	1.1	0.03	0.03	0.011	1.40	0.008	0.024	0.00	0.000	0.000	0.000	0.000
	W	5/20/63	136	5.1	0.0000	0.07	0.3	0.01	[illegible]	[illegible]	0.07	0.012	0.41	0.008	0.025	0.00	0.000	0.000	0.000	0.000
	SW	6/6/63	230	7.8	0.0000	0.07	0.3	0.01	2.0	0.10	0.05	0.014	1.80	0.008	0.025	0.00	0.000	0.000	0.000	0.000
	E	5/30/63	74	2.5	0.0000	0.01	0.1	0.00	0.3	0.04	0.01	0.010	0.00	0.000	0.023	0.00	0.000	0.000	0.010	0.000
534-702	SW	6/24/63	125	4.7	0.0000	0.03	0.4	0.00	2.1	0.02	0.03	0.000	0.00	0.000	0.021	0.00	0.000	0.000	0.000	0.000
	W	6/27/63	169	7.1	0.0000	0.04	0.5	0.01	1.5	0.03	0.03	0.000	0.39	0.000	0.016	0.00	0.000	0.000	0.021	0.000
	NE	7/8/63	66	3.4	0.0000	0.02	0.3	0.00	0.2	0.01	0.00	0.000	0.18	0.000	0.008	0.00	0.000	0.000	0.000	0.000
NASN[a]	-	-	176[b]	13.9[b]	-	0.08	0.4	0.06	3.2	0.08	0.08	0.320[c]	1.61	0.041	0.032	0.04[c]	0.000	0.000	0.150[c]	0.000
NASN[d]	-	-	145	10.7	-	0.14	0.5	0.06	2.9	0.08	0.08	-	0.53	0.045	0.032	-	-	-	-	-
NASN[e]	-	-	111[f]	7.8[f]	-	0.05	0.4	0.02	1.1	0.11	0.02	0.008	0.95	0.026	0.012	-	-	-	-	-
NASN[g]	-	-	184[f]	12.6[f]	-	0.09	1.1	0.01	[illegible]	0.1	0.05	0.004	[illegible]	0.029	0.026	-	-	-	-	-

[a] Arithmetic means from the NASN St. Louis station for 1958 (24 samples).[9]
[b] Arithmetic means from the NASN St. Louis station from 1957-1961 (124 samples).[9]
[c] Maximum of the 24 samples collected in 1958.[9]
[d] NASN arithmetic means for the Midwest for 1957-60.[9]
[e] Arithmetic means from the NASN St. Louis station for 1963 (25 samples).[32]
[f] Geometric mean.
[g] Arithmetic means from the NASN East St. Louis station for 1963 (23 samples).[32]

Table 17. DETAILED ANALYSIS OF SELECTED HIGH-VOLUME FILTERS, 1964

Site coordinates	Wind dir.	Date	Partic	Concentration, $\mu g/m^3$																
				Organic	Be	Mn	Pb	Sn	Fe	Cu	Ti	V	Zn	Cr	Ni	Mo	Co	Bi	Cd	Sb
432-715	S	1/6/64	92	9.7	0.0000	0.01	2.6	0.00	0.4	0.02	0.01	0.004	0.29	0.014	0.007	0.00	0.000	0.000	0.034	0.000
	S	1/17/64	78	4.6	0.0000	0.01	3.1	0.03	0.5	0.02	0.01	0.006	0.25	0.012	0.009	0.00	0.000	0.000	0.011	0.000
	N	1/27/64	49	1.5	0.0000	0.01	0.4	0.00	0.4	0.01	0.01	0.000	0.00	0.011	0.007	0.00	0.000	0.000	0.000	0.000
	E	2/3/64	130	5.3	0.0000	0.10	2.1	0.02	2.2	0.03	0.03	0.007	0.99	0.027	0.021	0.01	0.000	0.000	0.000	0.000
	W	2/8/64	41	1.6	0.0000	0.00	0.5	0.00	0.3	0.01	0.00	0.000	0.00	0.014	0.007	0.00	0.000	0.000	0.000	0.000
	S	2/11/64	66	1.2	0.0000	0.02	0.2	0.00	0.4	0.04	0.02	0.003	0.00	0.012	0.008	0.00	0.000	0.000	0.000	0.000
	SE	3/12/64	58	1.0	0.0000	0.02	0.2	0.01	0.9	0.25	0.05	0.004	0.00	0.028	0.012	0.00	0.000	0.000	0.000	0.000
	ESE	3/18/64	68	1.2	0.0000	0.04	0.3	0.01	1.2	0.04	0.02	0.003	0.39	0.026	0.016	0.00	0.000	0.000	0.000	0.000
438-689	N	1/27/64	44	0.5	0.0000	0.02	0.1	0.00	0.3	0.02	0.01	0.003	0.00	0.000	0.007	0.00	0.000	0.000	0.000	0.000
	S	1/6/64	95	6.5	0.0000	0.02	2.1	0.01	0.3	0.06	0.01	0.003	0.31	0.000	0.006	0.00	0.000	0.000	0.049	0.000
	E	2/3/64	142	6.2	0.0000	0.03	0.5	0.01	0.8	0.03	0.05	0.006	0.86	0.000	0.011	0.00	0.000	0.000	0.000	0.000
	W	2/8/64	39	1.2	0.0000	0.00	0.2	0.00	0.3	0.01	0.01	0.003	0.00	0.000	0.007	0.00	0.000	0.000	0.000	0.000
	S	2/11/64	77	1.4	0.0000	0.03	0.5	0.00	0.5	0.01	0.03	0.004	0.00	0.000	0.000	0.00	0.000	0.000	0.000	0.000
	SE	3/12/64	77	0.5	0.0000	0.02	0.5	0.00	0.8	0.03	0.03	0.004	1.40	0.000	0.011	0.00	0.000	0.000	0.000	0.000
	ESE	3/18/64	100	1.1	0.0000	0.03	0.3*	0.00	0.3	0.01	0.01	0.000	0.32	0.000	0.000	0.00	0.000	0.000	0.011	0.000
449-719	E	2/3/64	184	11.4	0.0000	0.12	2.8	0.06	1.5	0.04	0.06	0.015	1.20	0.037	0.020	0.01	0.000	0.000	0.000	0.000
	W	2/8/64	39	3.8	0.0000	0.00	0.3	0.00	0.3	0.01	0.01	0.000	0.00	0.019	0.000	0.00	0.000	0.000	0.000	0.000
	S	2/11/64	99	4.6	0.0000	0.04	0.4	0.00	0.7	0.03	0.04	0.005	0.00	0.000	0.009	0.00	0.000	0.000	0.000	0.000
468-665	S	1/6/64	88	3.7	0.0000	0.02	3.1	0.01	0.4	0.02	0.02	0.004	1.50	0.000	0.000	0.00	0.000	0.000	0.110	0.000
	S	1/17/64	76	3.0	0.0000	0.02	1.1	0.00	0.8	0.01	0.02	0.000	0.50	0.025	0.011	0.00	0.000	0.000	0.240	0.000
	N	1/27/64	89	3.5	0.0000	0.04	0.4	0.01	0.9	0.03	0.03	0.005	0.26	0.023	0.012	0.00	0.000	0.000	0.000	0.000
	E	2/3/64	66	3.9	0.0000	0.02	0.1	0.00	0.4	0.02	0.01	0.003	0.28	0.013	0.005	0.00	0.000	0.000	0.000	0.000
	W	2/8/64	26	1.1	0.0000	0.00	0.5	0.00	0.3	0.01	0.01	0.000	0.15	0.017	0.006	0.00	0.000	0.000	0.018	0.000
	SE	3/12/64	42	1.6	0.0000	0.00	0.0	0.00	0.1	0.00	0.01	0.000	0.00	0.000	0.000	0.00	0.000	0.000	0.000	0.000
	ESE	3/18/64	43	1.4	0.0000	0.02	0.2	0.00	0.5	0.02	0.01	0.000	0.00	0.000	0.005	0.00	0.000	0.000	0.000	0.000
469-750	N	1/27/64	58	3.1	0.0000	0.02	0.2	0.00	0.5	0.01	0.01	0.003	0.00	0.020	0.008	0.00	0.000	0.000	0.000	0.000
	E	2/3/64	129	6.3	0.0000	0.08	0.8	0.01	2.2	0.03	0.04	0.007	0.62	0.036	0.025	0.00	0.000	0.000	0.000	0.000
	W	2/8/64	60	6.6.	0.0000	0.00	1.9	0.00	0.4	0.00	0.00	0.000	0.00	0.017	0.007	0.00	0.000	0.000	0.000	0.000
	S	2/11/64	103	7.4	0.0000	0.07	1.4	0.03	1.2	0.03	0.03	0.006	0.60	0.030	0.015	0.00	0.000	0.000	0.000	0.000
	SE	3/12/64	110	6.6	0.0000	0.04	0.7	0.03	1.3	0.04	0.04	0.005	1.50	0.029	0.014	0.00	0.000	0.000	0.027	0.000
	ESE	3/18/64	94	6.8	0.0000	0.08	2.4	0.01	1.8	0.03	0.05	0.009	1.30	0.016	0.019	0.00	0.000	0.000	0.095	0.000
472-680	S	1/17/64	236	8.6	0.0000	0.05	2.4	0.01	4.7	0.04	0.25	0.010	1.10	0.140	0.180	0.01	0.000	0.000	0.065	0.050
	N	1/27/64	128	4.8	0.0000	0.09	0.8	0.03	1.1	0.03	0.08	0.009	0.59	0.010	0.023	0.00	0.000	0.000	0.000	0.000
	E	2/3/64	226	15.0	0.0000	0.11	0.4	0.01	3.9	0.04	0.07	0.004	1.50	0.018	0.041	0.00	0.000	0.000	0.000	0.000
	S	2/11/64	733	4.4	0.0034	0.16	0.3	0.01	14.0	0.04	0.65	0.024	0.51	0.820	0.500	0.04	0.012	0.000	0.000	0.220
	SE	3/12/64	973	5.4	0.0030	0.15	0.2	0.00	33.0	0.06	1.60	0.029	1.90	0.340	0.250	0.03	0.013	0.000	0.000	0.093
	ESE	3/18/64	114	3.7	0.0000	0.02	0.8	0.00	0.6	0.01	0.02	0.000	1.20	0.000	0.006	0.00	0.000	0.000	0.000	0.000

Table 17. (Cont'd) DETAILED ANALYSIS OF SELECTED HIGH-VOLUME FILTERS, 1964

Site coordinates	Wind dir.	Date	Partic	Concentration, ug/m^3																
				Organic	BE	Mn	Pb	Sn	Fe	Cu	Ti	V	Zn	Cr	Ni	Mo	Co	Bi	Cd	Sb
481-698	S	1/6/64	126	11.6	0.0000	0.09	2.9	0.02	2.2	0.04	0.05	0.011	1.60	0.020	0.023	0.00	0.000	0.000	0.120	0.000
	S	1/17/64	202	10.0	0.0000	0.16	2.0	0.00	3.1	0.02	0.10	0.015	0.76	0.021	0.034	0.01	0.000	0.000	0.060	0.060
	E	2/3/64	194	15.6	0.0000	0.06	0.7	0.01	3.0	0.02	0.06	0.013	4.40	0.024	0.034	0.01	0.000	0.000	0.000	0.000
	W	2/8/64	56	7.2	0.0000	0.03	0.9	0.00	0.9	0.03	0.07	0.011	0.44	0.019	0.012	0.00	0.000	0.000	0.000	0.000
	S	2/11/64	71	7.0	0.0000	0.04	0.2	0.01	0.6	0.02	0.04	0.007	0.00	0.010	0.008	0.00	0.000	0.000	0.000	0.000
	SE	3/12/64	79	3.4	0.0000	0.03	0.4	0.00	0.7	0.01	0.02	0.000	1.40	0.000	0.007	0.00	0.000	0.000	0.000	0.000
	ESE	3/18/64	101	19.3	0.0000	0.04	0.7	0.02	0.6	0.03	0.01	0.004	1.90	0.009	0.010	0.00	0.000	0.000	0.000	0.000
489-728	W	2/8/64	112	9.8	0.0000	0.05	2.3	0.01	1.2	0.08	0.03	0.009	0.65	0.009	0.017	0.00	0.000	0.000	0.016	0.000
	SE	3/12/64	137	5.6	0.0000	0.06	0.6	0.01	0.9	0.03	0.04	0.007	1.80	0.014	0.015	0.01	0.000	0.000	0.039	0.000
	ESE	3/18/64	130	5.3	0.0008	0.07	0.5	0.01	3.8	0.02	0.07	0.010	0.57	0.017	0.028	0.01	0.000	0.000	0.027	0.000
490-713	S	1/6/64	233	15.7	0.0000	0.07	2.4	0.04	2.2	0.36	0.04	0.013	3.10	0.030	0.033	0.01	0.000	0.000	0.160	0.000
	S	1/17/64	198	13.6	0.0000	0.07	2.7	0.02	3.5	0.10	0.15	0.035	1.20	0.027	0.057	0.01	0.000	0.000	0.130	0.000
	N	1/27/64	145	6.0	0.0000	0.06	0.6	0.02	1.2	0.02	0.05	0.022	0.45	0.016	0.028	0.01	0.000	0.000	0.000	0.000
	E	2/3/64	234	14.6	0.0000	0.07	1.0	0.00	1.7	0.05	0.03	0.006	1.30	0.014	0.018	0.01	0.000	0.000	0.000	0.000
	S	2/11/64	182	8.5	0.0000	0.12	1.5	0.04	3.4	0.16	0.12	0.014	3.20	0.037	0.030	0.01	0.000	0.001	0.220	0.000
	ESE	3/18/64	135	6.3	0.0000	0.09	0.4	0.00	1.5	0.02	0.04	0.005	0.42	0.025	0.011	0.00	0.000	0.000	0.000	0.000
494-703	S	1/6/64	200	14.9	0.0000	0.06	3.4	0.05	2.7	0.23	0.04	0.009	7.70	0.019	0.043	0.01	0.000	0.003	0.088	0.000
	S	1/17/64	176	24.1	0.0000	0.04	1.9	0.01	0.8	0.04	0.02	0.006	0.72	0.008	0.012	0.00	0.000	0.000	0.130	0.000
	N	1/27/64	116	4.8	0.0000	0.07	0.5	0.02	1.9	0.04	0.05	0.014	0.57	0.020	0.028	0.01	0.000	0.000	0.000	0.000
	E	2/3/64	[illegible]	25.1	0.0000	0.13	0.8	0.01	4.2	0.06	0.05	0.007	9.70	0.016	0.026	0.01	0.000	0.003	0.031	0.000
	ESE	3/18/64	[illegible]	5.8	0.0000	0.10	1.0	0.09	3.1	0.31	0.03	0.003	7.10	0.012	0.022	0.01	0.000	0.003	0.021	0.000
497-709	S	1/6/64	224	17.5	0.0000	0.11	4.9	0.06	3.6	0.69	0.04	0.013	9.90	0.023	0.066	0.01	0.000	0.002	0.340	0.000
	N	1/27/64	202	22.3	0.0000	0.08	1.0	0.01	3.4	0.02	0.07	0.013	0.48	0.009	0.024	0.01	0.000	0.000	0.000	0.000
	E	2/3/64	258	26.3	0.0000	0.15	3.2	0.02	6.2	0.14	0.06	0.008	2.80	0.029	0.052	0.01	0.000	0.000	0.031	0.000
	SE	3/12/64	150	5.8	0.0000	0.06	1.3	0.07	1.7	0.13	0.03	0.005	10.00	0.019	0.023	0.01	0.000	0.004	0.260	0.000
	ESE	3/18/64	157	10.3	0.0000	0.08	0.9	0.00	2.2	0.02	0.02	0.005	2.90	0.012	0.014	0.00	0.000	0.000	0.000	0.000
501-713	S	1/6/64	363	44.8	0.0000	0.08	2.2	0.03	2.6	0.13	0.02	0.008	11.00	0.000	0.028	0.01	0.000	0.000	0.035	0.000
	N	1/27/64	219	20.9	0.0000	0.08	0.5	0.02	3.2	0.02	0.05	0.010	1.10	0.011	0.025	0.01	0.000	0.000	0.000	0.000
	E	2/3/64	209	23.2	0.0000	0.07	0.7	0.01	2.3	0.07	0.02	0.006	1.10	0.000	0.022	0.01	0.000	0.000	0.013	0.000
	W	2/8/64	214	33.0	0.0000	0.06	0.9	0.02	3.3	0.09	0.06	0.009	1.50	0.011	0.028	0.01	0.000	0.000	0.000	0.000
	S	2/11/64	165	12.4	0.0000	0.05	0.5	0.00	1.2	0.05	0.03	0.006	1.20	0.010	0.012	0.00	0.000	0.000	0.030	0.000
	ESE	3/18/64	146	7.7	0.0000	0.04	0.5	0.00	1.1	0.01	0.02	0.004	1.90	0.000	0.010	0.00	0.000	0.000	0.000	0.000

Table 17. (Cont'd) DETAILED ANALYSIS OF SELECTED HIGH-VOLUME FILTERS, 1964

Site coordinates	Wind dir.	Date	Partic	Concentration, $\mu g/m^3$																
				Organic	Be	Mn	Pb	Sn	Fe	Cu	Ti	V	Zn	Cr	Ni	Mo	Co	Bi	Cd	Sb
505-740	S	1/6/64	602	24.8	0.0017	0.40	2.9	0.07	53.0	0.15	0.37	0.043	6.00	0.062	0.100	0.04	0.008	0.000	0.032	0.000
	S-SE	1/28/64	415	12.8	0.0010	0.45	1.8	0.03	46.0	0.15	0.21	0.032	9.30	0.083	0.093	0.01	0.000	0.000	0.034	0.000
	N	1/27/64	153	4.3	0.0000	0.10	0.1	0.00	1.8	0.05	0.06	0.027	0.58	0.015	0.039	0.00	0.000	0.000	0.000	0.000
	E	2/3/64	161	10.6	0.0000	0.55	0.5	0.01	3.4	0.05	0.10	0.013	0.70	0.032	0.028	0.00	0.000	0.000	0.000	0.000
	E	2/2/64	78	4.5	0.0000	0.03	0.2	0.00	0.9	0.03	0.04	0.005	0.00	0.011	0.010	0.01	0.000	0.000	0.000	0.000
	WNW	12/9/63	110	4.6	0.0000	0.05	0.2	0.00	0.9	0.02	0.03	0.005	0.00	0.014	0.011	0.00	0.000	0.000	0.000	0.000
	SSW	12/6/63	280	11.4	0.0013	0.51	1.3	0.02	21.0	0.12	0.25	0.019	2.70	0.049	0.057	0.02	0.000	0.000	0.025	0.000
520-798	N	1/27/64	164	4.8	0.0000	0.08	0.5	0.01	2.1	0.04	0.01	0.013	0.84	0.014	0.022	0.01	0.000	0.000	0.000	0.000
	E	2/5/64	144	11.4	0.0000	0.03	0.5	0.00	1.1	0.02	0.05	0.019	0.47	0.000	0.022	0.00	0.000	0.000	0.000	0.000
	S	2/11/64	228	12.1	0.0000	0.04	0.2	0.01	3.0	0.01	0.10	0.033	0.27	0.000	0.035	0.00	0.000	0.000	0.000	0.000
534-702	S	1/6/64	108	5.1	0.0000	0.10	0.3	0.01	1.0	0.02	0.05	0.006	0.49	0.014	0.011	0.00	0.000	0.000	0.000	0.000
	S	1/17/64	209	11.7	0.0000	0.05	1.8	0.00	2.5	0.01	0.08	0.006	0.25	0.009	0.016	0.01	0.000	0.000	0.010	0.000
	SE	3/12/64	66	2.4	0.0000	0.01	0.1	0.00	0.4	0.00	0.01	0.000	1.20	0.000	0.000	0.00	0.000	0.000	0.000	0.000
	ESE	3/18/64	76	4.5	0.0000	0.05	0.2	0.00	1.4	0.02	0.03	0.000	2.30	0.000	0.016	0.00	0.000	0.000	0.000	0.000

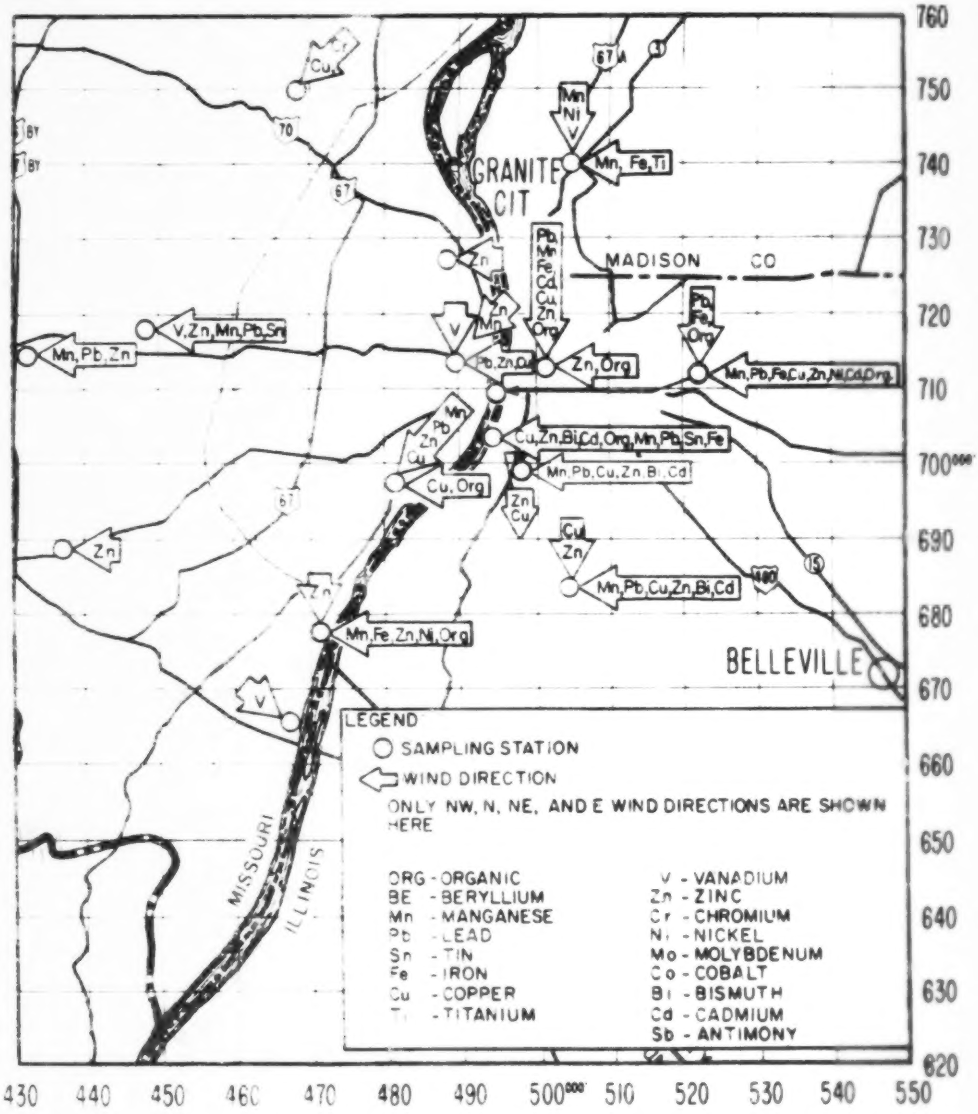
GRANITE CIT
MADISON CO
BELLEVILLE
MISSOURI
ILLINOIS
Cu, Cr
Mn Ni V
Mn, Fe, Ti
Zn
Pb Mn Fe Cd Cu Zn Org
Pb Fe Org
Zn Mn
V
V, Zn, Mn, Pb, Sn
Mn, Pb, Zn
Pb, Zn, Cd
Zn, Org
Mn, Pb, Fe, Cu, Zn, Ni, Cd, Org
Mn Pb Zn Cu
Cu, Zn, Bi, Cd, Org, Mn, Pb, Sn, Fe
Mn, Pb, Cu, Zn, Bi, Cd
Cu, Org
Zn Cu
Cu Zn
Zn
Mn, Pb, Cu, Zn, Bi, Cd
Zn
Mn, Fe, Zn, Ni, Org
V
LEGEND
SAMPLING STATION
WIND DIRECTION
ONLY NW, N, NE, AND E WIND DIRECTIONS ARE SHOWN HERE
ORG - ORGANIC
BE - BERYLLIUM
Mn - MANGANESE
Pb - LEAD
Sn - TIN
Fe - IRON
Cu - COPPER
Ti - TITANIUM
V - VANADIUM
Zn - ZINC
Cr - CHROMIUM
Ni - NICKEL
Mo - MOLYBDENUM
Co - COBALT
Bi - BISMUTH
Cd - CADMIUM
Sb - ANTIMONY
760
750
740
730
720
710
700000
690
680
670
660
650
640
630
620
430
440
450
460
470
480
490
500000
510
520
530
540
550
70
67
67
67A
BY
BY
480
15

Figure 56. Geographic distribution of airborne metals and organic particulates from northwest, north, northeast, and east.

Figure 57 shows the seasonal and yearly results from the NASN rural Missouri and St. Louis sites, and the Interstate Air Pollution Study site 490-713. Table 18 gives the 1963 NASN data for St. Louis, East St. Louis, and selected other cities. Of the 15 cities listed, East St. Louis ranked next to highest for suspended particulates (geometric means) and St. Louis ranked 11th.

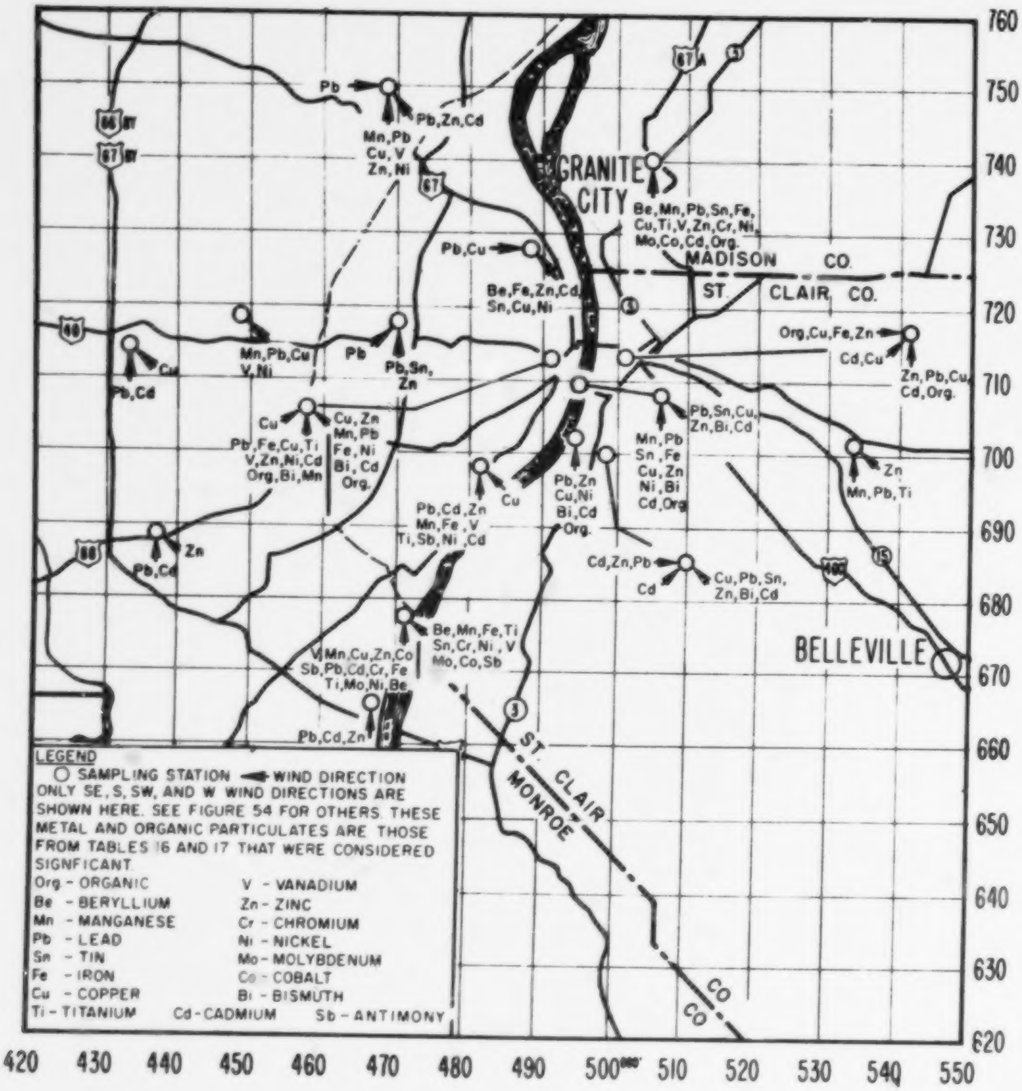
Pb
Pb,Zn,Cd
Mn,Pb
Cu,V
Zn,Ni
GRANITE
CITY
Be,Mn,Pb,Sn,Fe,
Cu,Ti,V,Zn,Cr,Ni,
Mo,Co,Cd,Org.
Pb,Cu
Be,Fe,Zn,Cd
Sn,Cu,Ni
MADISON CO.
ST. CLAIR CO.
Org,Cu,Fe,Zn
Cd,Cu
Zn,Pb,Cu,
Cd,Org.
Mn,Pb,Cu
V,Ni
Pb
Pb,Sn,
Zn
Cu
Pb,Cd
Cu
Cu,Zn
Mn,Pb
Fe,Ni
Bi,Cd
Org.
Pb,Fe,Cu,Ti
V,Zn,Ni,Cd
Org,Bi,Mn
Pb,Sn,Cu,
Zn,Bi,Cd
Mn,Pb
Sn,Fe
Cu,Zn
Ni,Bi
Cd,Org
Zn
Mn,Pb,Ti
Cu
Pb,Zn
Cu,Ni
Bi,Cd
Org.
Pb,Cd,Zn
Mn,Fe,V
Ti,Sb,Ni,Cd
Zn
Pb,Cd
Cd,Zn,Pb
Cd
Cu,Pb,Sn,
Zn,Bi,Cd
Be,Mn,Fe,Ti
Sn,Cr,Ni,V
Mo,Co,Sb
V,Mn,Cu,Zn,Co
Sb,Pb,Cd,Cr,Fe
Ti,Mo,Ni,Be
BELLEVILLE
Pb,Cd,Zn
ST. CLAIR
MONROE
CO
CO
66
67
40
67A
3
3
460
15
LEGEND
SAMPLING STATION
WIND DIRECTION
ONLY SE, S, SW, AND W WIND DIRECTIONS ARE SHOWN HERE. SEE FIGURE 54 FOR OTHERS. THESE METAL AND ORGANIC PARTICULATES ARE THOSE FROM TABLES 16 AND 17 THAT WERE CONSIDERED SIGNFICANT.
Org - ORGANIC
Be - BERYLLIUM
Mn - MANGANESE
Pb - LEAD
Sn - TIN
Fe - IRON
Cu - COPPER
Ti - TITANIUM
V - VANADIUM
Zn - ZINC
Cr - CHROMIUM
Ni - NICKEL
Mo - MOLYBDENUM
Co - COBALT
Bi - BISMUTH
Cd - CADMIUM
Sb - ANTIMONY
760
750
740
730
720
710
700
690
680
670
660
650
640
630
620
420
430
440
450
460
470
480
490
500000
510
520
530
540
550

Figure 55. Geographic distribution of airborne metals and organic particulates from southeast, south, southwest, and west.

CARCINOGENS

One of the polynuclear hydrocarbons found in the urban atmosphere is benzo(a) pyrene, also known as 3,4-benzpyrene, hereafter referred to in this report as BaP.

BaP is carcinogenic to experimental animals and is suspected of being carcinogenic to man. BaP is only one of several polynuclear hydrocarbons that

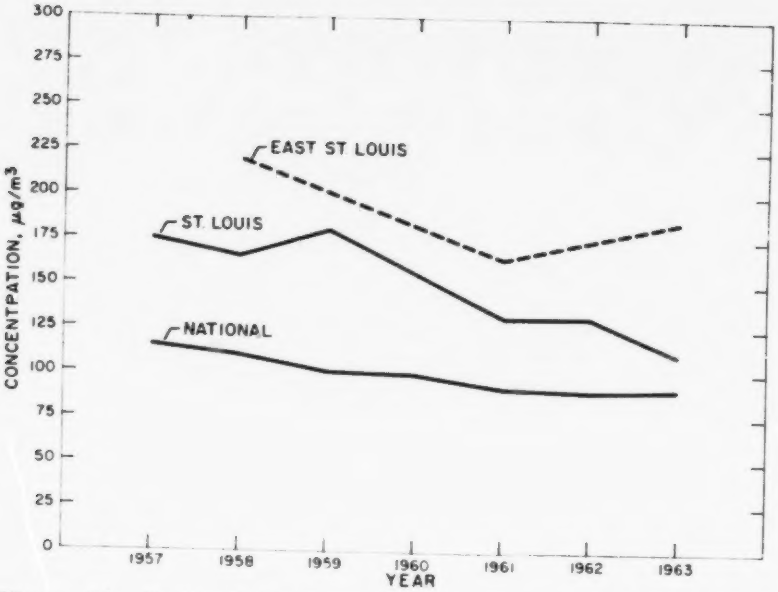

Figure 56. National Air Sampling Network suspended particulate geometric means by years.

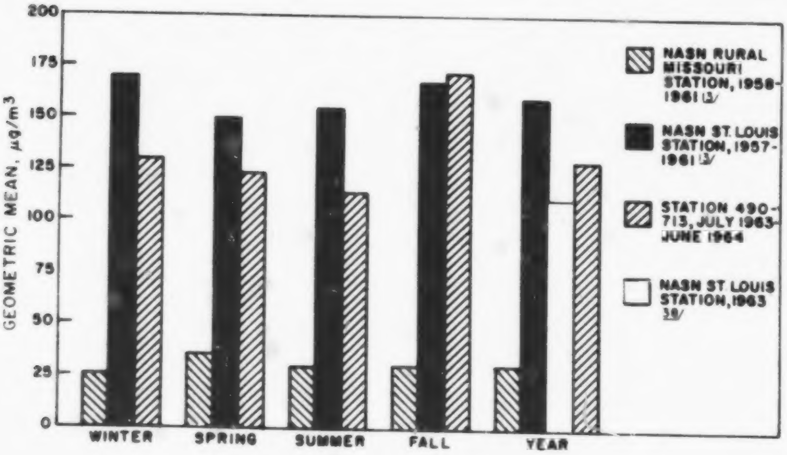

Figure 57. Comparison of geometric means of suspended particulates measured with high-volume air sampler.

Table 18. COMPARISON OF THE SUSPENDED PARTICULATE AND SULFUR DIOXIDE LEVELS OF SOME CITIES FROM 1963 NATIONAL AIR SAMPLING NETWORK DATA[a]

City	Suspended particulates, μg/m^3		Sulfur dioxide, ppm	
	Geometric mean	Maximum	Arithmetic mean	Maximum
E. St. Louis	184	550	--	--
St. Louis	111	180	0.02	0.10
Atlanta	96	186	0.01	0.03
Birmingham	129	505	0.01	0.05
Chicago	137	257	0.11	0.30
Cincinnati	116	204	0.02	0.06
Denver	169	673	0.01	0.02
Detroit	116	404	0.02	0.07
Los Angeles	114	251	< 0.01	0.01
Nashville	124	285	0.01	0.05
New Orleans	91	187	< 0.01	0.01
New York	189	431	0.15	0.35
Philadelphia	148	308	0.10	0.27
San Francisco	64	158	< 0.01	0.01
Washington, D. C.	108	231	0.03	0.08
National	92	710	0.03	0.38

[a] See reference 62.

exist in the air over cities. It exists in the atmosphere as a solid, arising from incomplete combustion of fuels such as coal, oil, and gasoline and certain types of refuse.

The BaP content of the air of 94 urban and 28 nonurban areas was reported in a paper by Sawicki.[13] The BaP content was determined by single pooled samples from the regular high-volume air samples collected by the NASN from January to March 1959. They are reported in Table 19. Of all the areas sampled, St. Louis had next to the highest values at that time. In 1963 three high-volume air samples, collected on October 8, 9, and 14, at site 490-713 (Municipal Courts Building in St. Louis) were composited, and 2.1 micrograms of BaP per 1000 cubic meters of air was found. This quantity is approximately 1/25th the amount found in January to March 1959. The difference may be accounted for in part by the fact that suspended particulate levels may have been abnormally high in 1959. Comparison revealed that they were

Table 19. BENZO(a)PYRENE CONCENTRATIONS IN URBAN SAMPLING SITES FOR JANUARY THROUGH MARCH 1959

State	City	µg BaP per g part	µg BaP per g benz sol fraction	µg BaP per 1,000 m^3 air	State	City	µg BaP per g part	µg BaP per g benz sol fraction	µg BaP per 1,000 m^3 air
Alabama	Montgomery	340	2,000	24	Nevada	Las Vegas	16	160	1.4
Alaska	Anchorage	64	540	3.8	New Hampshire	Manchester	53	600	6.0
Arizona	Phoenix	15	160	5.0	New Jersey	Bayonne	33	410	5.5
Arkansas	Little Rock	20	230	1.5		Jersey City	33	440	6.0
California	Berkeley	41	260	2.9		Newark	46	500	4.5
	Glendale	5.3	38	0.8		Paterson	51	610	6.3
	San Bernardino	13	140	2.3	New Mexico	Albuquerque	15	460	6.3
	San Diego	20	150	2.1	North Carolina	Charlotte	290	2,100	39
	San Jose	7.2	91	0.56		Raleigh	180	1,300	14
Colorado	Denver	51	290	6.9	North Dakota	Bismarck	5.8	130	0.44
Connecticut	Hartford	68	730	6.5	Ohio	Cleveland	110	1,200	24
	New Britain	50	450	5.5		Columbus	70	930	9.5
	New Haven	53	580	5.3		Dayton	78	760	7.9
Delaware	Wilmington	55	650	10		Hamilton	83	600	14
District of Columbia	Washington	71	59	9.3		Toledo	100	1,200	11
Florida	Miami	28	250	1.9		Youngstown	190	2,000	28
	Orlando	110	810	11	Oklahoma	Tulsa	13	180	1.0
	Tampa	140	1.200	15	Oregon	Portland	96	730	8.0
Georgia	Savannah	> 49	> 480	> 4.3	Pennsylvania	Allentown	26	440	3.4
Illinois	Chicago	74	950	15		Altoona[a]	280	1,400	61
	Rockford	63	660	7.3		Erie	70	1,000	9.5
Indiana	East Chicago[a]	34	710	11.1		Johnstown	58	660	16
	Indianapolis	120	1,100	26		Pittsburgh	16	200	5.1
	Hammond	280	2,600	39		Scranton	33	360	6.1
	South Bend	91	200	16		York	31	510	5.6
Iowa	DesMoines	160	1,600	23	Rhode Island	Providence	24	240	2.9
Kansas	Topeka	40	510	3.1	South Carolina	Charleston	68	530	5.6
	Wichita	19	310	2.3		Columbia[a]	120	750	24
Kentucky	Louisville	70	860	16	South Dakota	Sioux Falls	31	480	4.0
Louisiana	Shreveport	6.4	150	0.65	Tennessee	Chattanooga	120	1,000	31
Maine	Portland	180	2,100	21		Knoxville	210	1,900	24
Maryland	Baltimore	64	650	14	Texas	Beaumont	13	200	0.82
Massachusetts	Boston	45	730	9.6		Dallas	6.1	160	1.4
	Lowell	40	410	3.1		Galveston	3.4	50	0.16
	New Bedford	81	1.000	4.4		Houston	12	210	1.6
	Worcester	66	700	14		San Antonio	5.8	110	0.86
Michigan	Dearborn	110	960	9.0	Utah	Salt Lake City	5.4	54	0.52
	Flint	140	1,400	15	Vermont	Burlington	28	39	1.0
	Grand Rapids	91	1,400	15	Virginia	Norfolk	59	580	8.4
Minnesota	Duluth[b]	110	1,500	12		Richmond	410	1,900	45
	Minneapolis	73	1,600	14		Roanoke	160	1,100	18
Mississippi	Jackson	24	230	1.2	Washington	Seattle	81	790	9.0
Missouri	Kansas City	46	540	6.5	West Virginia	Charleston[a]	40	900	14
	St. Louis[a]	200	1,800	54		Wheeling	140	1,600	21
Montana	Helena	2.4	51	0.11	Wisconsin	Madison	80	830	4.9
Nebraska	Omaha	33	460	3.5		Milwaukee	60	730	8.5
					Wyoming	Cheyenne	36	340	1.2

[a] In respect to the cities with benzpyrene levels greater than 11 µg per 1,000 m^3 of air, 5 cities had a concentration of particulates in the air 1.5 to 2 times higher than in the corresponding January to March period in 1958.

[b] The concentration of particulates in the air for this city in January to March 1959 was half that found in the corresponding period of 1958.

approximately twice as high in St. Louis during the 1959 sampling period as they were for the same period in the preceding year. Furthermore, October is not part of the heating season when larger amounts of BaP could be expected. Samples were analyzed by the Public Health Service, Laboratory of Engineering and Physical Science.

To determine the winter-time levels of BaP in the Study area, pooled samples of suspended particulates, collected at 14 sampling stations were analyzed. The samples were composited from three to seven 24-hour samples collected with high-volume samplers during the period from January 6 and March 18, 1964. They generally represent the days of higher-than-average heating requirements. The results, summarized in Table 20, varied from 1.4 micrograms of BaP per 1,000 cubic meters of air on the outskirts of the Study area to 28.0 micrograms per 1,000 cubic meters just north of downtown St. Louis. The arithmetic mean concentration of the 14 samples analyzed was 10.2 micrograms per 1,000 cubic meters. As expected, the higher concentrations were observed in areas where coal is burned domestically. Table 19 shows that the BaP concentrations in the Study area are comparable to the concentrations found in cities similar to St. Louis in size and the general makeup of air pollution sources.

Table 20. BENZO(a)PYRENE CONCENTRATIONS IN INTERSTATE STUDY STUDY AREA, JANUARY-MARCH, 1964[a]

Sampling site	Suspended particulates[b]	Benzo(a)Pyrene		Benzene soluble
(grid coordinates)	$\mu g/m^3$	$\mu g/1{,}000\ m^3$ air	$\mu g/g$ of benzene soluble	$\mu g/m^3$ air
438-689	75	1.5	570	2.6
449-719	89	5.3	830	6.3
468-665	57	1.4	570	2.4
469-750	89	3.8	620	6.1
472-680	287	24.0	3,510	6.8
481-698	107	4.9	470	10.5
489-728	126	28.0	4,220	6.6
490-713	184	5.6	530	5.6
494-703	191	18.8	1,350	14.0
495-709	194	15.7	970	16.2
501-713	218	1.7	67	23.7
505-740	283	11.4	1,130	10.1
520-798	175	15.8	1,670	9.4
534-702	136	4.4	740	6.0

[a] One composite sample for each site, pooled from 3 to 7 individual samples collected between January 6 and March 18, 1964.

[b] Geometric mean of 3 to 7 filter samples comprising the composite sample for analysis.

Analysis of the sample collected at site 501-713 revealed a phenanthrene concentration of 140 micrograms per 1,000 cubic meters of air. This high value of phenanthrene is not typical of what is known concerning this pollutant at this time. Samples from other sites did not show sufficient concentrations for analysis. As emission source information is obtained, review and further investigation of polynuclear hydrocarbons is warranted.

PARTICULATE SULFATE

During December 1963 through February 1964 millipore filters used in the inlets to sulfur dioxide samplers were saved for microscopic examination. Although particles on the filter were too numerous to count, the examination revealed that sulfate crystals were the most numerous.

The high-volume air sampler filters collected at the St. Louis NASN station in 1958, 1962, and 1963 were analyzed for particulate sulfate levels. The yearly averages of these results are as follows: 18.2 micrograms per cubic meter in 1958,[9] 14.6 micrograms per cubic meter in 1962,[69] and 13.1 micrograms per cubic meter in 1963.[62] The national average for 1957-60 was 11.8 micrograms per cubic meter[9] and 10.1 micrograms per cubic meter in 1963.[62]

SUSPENDED PARTICULATES MEASURED BY AISI SAMPLER (Soiling Index)

AISI samplers were located at 12 sites. The results, given in Table 21, ranged from 0.00 to 19.11 Cohs per 1,000 lineal feet. The geometric means for the period July 1963 through June 1964 ranged from 0.145 Coh per 1,000 lineal feet at site 468-665, which was a low-density residential area, to 1.623 Coh per 1,000 lineal feet for 499-700, which was a heavily industrialized area.

Figures 58 and 59 are isopleth maps of AISI sampler annual geometric means and the 99th percentile values based on the annual geometric means, respectively. Both maps show that the area with highest pollution levels is in Illinois and that it extends both north and south of East St. Louis.

The State of New Jersey has prepared the following adjectival rating scale for suspended particulates by AISI sampler.[14]

0-0.9 Coh per 1,000 lineal feet - light
1.0-1.9 Cohs per 1,000 lineal feet - moderate
2.0-2.9 Cohs per 1,000 lineal feet - heavy
3.0-3.9 Cohs per 1,000 lineal feet - very heavy
4.0-4.9 Cohs per 1,000 lineal feet - extremely heavy

The State of Colorado has adopted an air quality standard of 0.5 Coh per 1,000 lineal feet of air, when measured in the central business district of a city or community on at least every third day and averaged over any 3-month period.[8] The Colorado standard was exceeded at site 490-713 in downtown St. Louis for three of the four seasons, and at site 501-713 in downtown East St. Louis for all four seasons.

Table 21. SUSPENDED PARTICULATES BY AISI SAMPLER, (Cohs/1,000 lineal feet)

Site coordinates	Minimum	Maximum	N[a]	Arithmetic		Geometric	
				Mean	Standard deviation	Mean	Standard deviation
July 1963							
432-715	0.00	0.60	132	0.269	0.109	0.246	1.586
449-719	0.04	1.76	343	0.303	0.222	0.237	2.082
468-665	0.00	2.10	310	0.311	0.206	0.252	2.198
469-750	0.00	1.90	136	0.260	0.227	0.196	2.327
472-680	0.00	3.20	103	0.855	0.641	0.638	2.341
501-713	0.09	3.56	258	0.850	0.555	0.699	1.911
Aug							
438-689	0.00	1.29	359	0.260	0.192	0.193	2.394
449-719	0.00	1.99	368	0.386	0.279	0.291	2.330
490-713	0.00	2.69	290	0.440	0.350	0.315	2.678
501-713	0.18	4.96	341	1.197	0.857	0.956	1.973
Sept							
438-689	0.00	0.60	162	0.193	0.122	0.139	2.686
449-719	0.00	1.09	118	0.352	0.228	0.269	2.374
490-713	0.00	4.80	307	0.749	0.624	0.559	2.314
501-713	0.09	5.47	331	1.419	0.994	1.126	2.034
505-740	0.00	5.65	338	0.879	0.781	0.608	2.621
Oct							
438-689	0.00	2.13	184	0.313	0.292	0.239	2.122
469-750	0.00	3.25	120	0.560	0.541	0.340	3.178
495-709	0.18	5.73	125	0.936	0.737	0.757	1.871
501-713	0.18	11.12	333	1.912	1.432	1.574	1.831
520-798	0.09	5.13	274	0.772	0.644	0.602	2.032
Nov							
432-715	0.00	4.45	204	0.542	0.615	0.311	3.251
438-689	0.00	2.40	358	0.351	0.366	0.233	2.587
449-719	0.00	2.50	200	0.516	0.461	0.317	3.215
468-665	0.00	1.02	155	0.325	0.249	0.204	3.246
469-750	0.00	4.02	347	0.750	0.750	0.477	2.882
495-709	0.09	9.71	299	1.501	1.348	1.086	2.275
501-713	0.18	16.60	302	3.066	2.926	2.002	2.594
520-798	0.00	5.83	280	1.129	1.031	0.785	2.484
Dec							
432-715	0.00	1.92	260	.331	0.370	0.164	3.895
438-689	0.00	5.04	358	.429	0.420	0.294	2.643
449-719	0.00	3.07	307	.621	0.562	0.417	2.631
468-665	0.00	1.19	282	.123	0.155	0.062	3.457
469-750	0.00	3.00	369	.637	0.523	0.462	2.397
495-709	0.09	7.69	370	1.782	1.431	1.296	2.329
501-713	0.36	12.71	372	3.565	2.392	2.787	2.109
520-798	0.00	6.40	264	1.193	0.930	0.898	2.234
Jan 1964							
432-715	0.00	3.39	358	0.396	0.436	0.227	3.324
438-689	0.00	2.30	314	0.349	0.315	0.241	2.642
449-719	0.00	3.85	366	0.591	0.566	0.381	2.874
468-665	0.00	1.18	226	0.230	0.219	0.135	3.196
469-750	0.00	4.65	364	0.778	0.697	0.527	2.565
490-713	0.18	6.81	225	1.652	1.177	1.299	2.056
495-709	0.09	13.16	226	1.485	1.550	1.034	2.357
499-700	0.18	7.69	159	1.853	1.495	1.409	2.094
501-713	0.55	19.11	359	4.354	2.924	3.422	2.089
505-740	0.18	9.80	198	2.339	1.621	1.789	2.225

Table 21. (Cont'd) SUSPENDED PARTICULATES BY AISI SAMPLER, (Cohs/1,000 lineal feet)

Site coordinate	Minimum	Maximum	N[a]	Arithmetic		Geometric	
				Mean	Standard deviation	Mean	Standard deviation
Feb 1964							
499-700	0.93	7.23	27	3.480	1.786	2.984	1.820
432-715	0.00	3.46	345	0.452	0.501	0.264	3.116
438-689	0.00	3.01	347	0.402	0.389	0.263	2.772
449-719	0.00	3.62	347	0.623	0.634	0.380	2.972
468-665	0.00	2.34	192	0.347	0.335	0.244	2.475
469-750	0.00	3.97	348	0.698	0.659	0.486	2.378
472-680	0.00	5.65	348	1.138	0.930	0.802	2.564
490-713	0.18	8.67	196	1.732	1.346	1.352	2.013
495-709	0.09	9.22	249	1.765	1.637	1.244	2.375
501-713	0.36	18.18	342	3.458	3.014	2.430	2.384
505-740	0.18	8.94	348	1.837	1.498	1.383	2.117
Mar							
432-715	0.00	1.54	372	0.314	0.263	0.224	2.435
438-689	0.00	1.59	371	0.267	0.215	0.192	2.487
449-719	0.00	2.51	337	0.471	0.376	0.322	2.755
468-665	0.00	0.65	150	0.181	0.128	0.125	2.847
469-750	0.00	4.57	370	0.502	0.534	0.321	2.738
472-680	0.00	5.47	262	1.173	0.894	0.889	2.281
490-713			0				
495-709	0.18	1.44	9	0.464	0.452	0.340	2.150
501-713	0.27	11.12	361	2.290	1.873	1.731	2.123
505-740	0.00	7.23	372	1.276	1.248	0.833	2.690
April							
432-715	0.00	1.43	360	.213	0.169	0.148	2.709
438-689	0.00	0.68	348	.181	0.132	0.131	2.537
449-719	0.00	1.70	324	.307	0.250	0.210	2.699
468-665	0.00	0.36	69	.125	0.104	0.076	3.160
469-750	0.00	1.71	360	.304	0.246	0.221	2.467
472-680	0.00	2.94	240	.793	0.545	0.579	2.694
490-713	0.00	3.89	237	.702	0.540	0.564	1.981
495-709	0.00	5.30	259	.739	0.638	0.481	3.122
501-713	0.00	8.94	355	1.346	1.199	0.999	2.210
505-740	0.00	7.69	267	1.210	1.123	0.834	2.541
520-798	0.09	4.64	91	.662	.567	.522	1.987
May							
432-715	0.00	0.83	372	0.208	0.149	0.154	2.403
438-689	0.00	0.94	360	0.179	0.130	0.134	2.353
449-719	0.00	2.22	322	0.297	0.209	0.231	2.281
469-750	0.40	2.32	89	0.286	0.267	0.229	1.883
472-680	0.90	2.94	63	0.962	0.540	0.828	1.778
490-713	0.00	4.64	261	0.618	0.464	0.479	2.286
495-709	0.00	4.96	319	0.746	0.745	0.479	2.995
501-713	0.00	5.47	372	0.925	0.713	0.734	2.007
505-740	0.00	6.60	259	1.059	0.899	0.742	2.539
June							
432-715	0.00	0.63	184	0.215	0.134	0.163	2.430
438-689	0.00	1.39	353	0.194	0.165	0.138	2.488
449-719	0.00	1.77	341	0.302	0.238	0.221	2.335
490-713	0.00	2.21	301	0.534	0.337	0.415	2.413
495-709	0.00	4.03	174	0.610	0.517	0.412	2.978
501-713	0.00	3.89	361	0.766	0.579	0.599	2.133

Table 21. (Cont'd) SUSPENDED PARTICULATES BY AISI SAMPLER, (Cohs/1,000 lineal feet)

Site coordinates	Minimum	Maximum	N^a	Arithmetic		Geometric	
				Mean	Standard deviation	Mean	Standard deviation
Summer 1963							
432-715	0.00	1.00	301	0.268	0.150	0.216	2.270
438-689	0.00	1.29	359	0.260	0.192	0.193	2.394
449-719	0.00	2.12	968	0.360	0.273	0.273	2.221
468-665	0.00	2.10	509	0.288	0.182	0.227	2.379
469-750	0.00	1.90	364	0.287	0.199	0.231	2.106
472-680	0.00	3.20	158	0.721	0.586	0.496	2.813
490-713	0.00	2.69	290	0.440	0.350	0.315	2.678
501-713	0.00	4.96	814	0.974	0.708	0.781	1.967
Fall 1963							
432-715	0.00	4.45	204	.542	0.615	0.311	3.251
438-689	0.00	2.40	704	.305	0.312	0.208	2.553
449-719	0.00	2.50	318	.456	0.399	0.298	2.906
469-750	0.00	4.02	467	.701	0.706	0.437	2.984
490-713	0.00	4.80	307	.749	0.624	0.559	2.314
495-709	0.09	9.71	424	1.335	1.[illegible]8	0.976	2.195
501-713	0.09	16.60	966	2.104	2.044	1.513	2.221
505-740	0.00	5.65	338	.879	0.781	0.608	2.621
520-798	0.00	5.83	554	.952	0.879	0.688	2.286
Winter 1963-64							
432-715	0.00	3.46	963	0.399	0.447	0.219	3.445
438-689	0.00	5.04	1019	0.395	0.380	0.266	2.693
449-719	0.00	3.85	1020	0.611	0.588	0.391	2.834
468-665	0.00	2.34	700	0.219	0.253	0.116	3.530
469-750	0.00	4.65	1081	0.704	0.632	0.491	2.450
472-680	0.00	5.65	353	1.139	0.924	0.806	2.551
490-713	0.18	8.67	421	1.689	1.257	1.323	2.035
495-709	0.09	13.16	845	1.698	1.530	1.206	2.360
499-700	0.00	8.67	215	2.259	1.870	1.623	2.385
501-713	0.36	19.11	1073	3.795	2.808	2.858	2.217
505-740	0.18	9.80	546	2.019	1.561	1.518	2.176
520-798	0.00	6.40	264	1.193	0.930	0.898	2.234
Spring 1964							
432-715	0.00	1.54	1104	0.246	0.206	0.173	2.559
438-689	0.00	1.59	1079	0.210	0.169	0.151	2.498
449-719	0.00	2.51	983	0.360	0.300	0.251	2.625
468-665	0.00	0.65	219	0.164	0.124	0.107	3.009
472-680	0.00	5.47	565	0.998	0.748	0.735	2.460
505-740	0.00	7.69	898	1.194	1.122	0.806	2.603
520-798	0.09	4.64	91	0.662	0.567	0.522	1.987
469-750	0.00	4.57	819	0.391	0.416	0.262	2.571
490-713	0.00	4.64	498	0.658	0.503	0.518	2.150
495-709	0.00	5.30	587	0.739	0.696	0.477	3.036
501-713	0.00	11.12	1088	1.515	1.460	1.079	2.288

Table 21. (Cont'd) SUSPENDED PARTICULATES BY AISI SAMPLER, (Cohs/1,000 lineal feet)

Site coordinates	Minimum	Maximum	N[a]	Arithmetic Mean	Arithmetic Standard deviation	Geometric Mean	Geometric Standard deviation
July 1963-June 1964							
432-715	0.00	4.45	2587	0.325	0.365	0.200	2.929
438-689	0.00	5.04	3514	0.286	0.288	0.193	2.636
449-719	0.00	3.85	3373	0.436	0.424	0.291	2.658
468-665	0.00	2.34	1384	0.243	0.233	0.145	3.278
469-750	0.00	4.65	2503	0.577	0.593	0.372	2.716
472-680	0.00	5.65	1021	1.027	0.808	0.748	2.484
490-713	0.00	8.67	1817	0.857	0.870	0.581	2.606
495-709	0.00	13.16	2030	1.251	1.283	0.805	2.836
499-700	0.00	8.67	215	2.259	1.870	1.623	2.385
501-713	0.00	19.11	4087	2.118	2.214	1.380	2.546
505-740	0.00	9.80	1811	1.370	1.295	0.906	2.699
520-798	0.00	6.40	909	0.993	0.882	0.723	2.275
July 1963 All	0.00	3.56	1282	0.451	0.433	0.319	2.395
August All	0.00	4.96	1387	0.564	0.610	0.354	2.843
September All	0.00	5.65	1256	0.852	0.832	0.537	2.958
October All	0.00	11.12	1036	1.052	1.125	0.669	2.761
November All	0.00	16.60	2145	1.091	1.597	0.539	3.528
December All	0.00	12.71	2611	1.186	1.627	0.507	4.406
January 1964 All	0.00	19.11	2800	1.370	1.884	0.620	3.986
February All	0.00	18.18	3089	1.267	1.672	0.657	3.407
March All	0.00	11.12	2604	0.845	1.157	0.431	3.413
April All	0.00	8.94	2910	0.607	0.760	0.335	3.323
May All	0.00	6.60	2417	0.555	0.625	0.334	2.981
June All	0.00	4.03	1714	0.440	0.430	0.285	2.831
Spring '64 All	0.00	11.12	7931	0.669	0.887	0.363	3.266
Summer '63 All	0.00	4.96	3894	0.476	0.484	0.321	2.613
Fall '63 All	0.00	16.60	4437	1.014	1.317	0.566	3.196
Winter'63-'64 All	0.00	19.11	8500	1.276	1.733	0.595	3.915
Year '63-'64 All	0.00	19.11	25274	0.901	1.304	0.453	3.471

[a] N = number of samples.

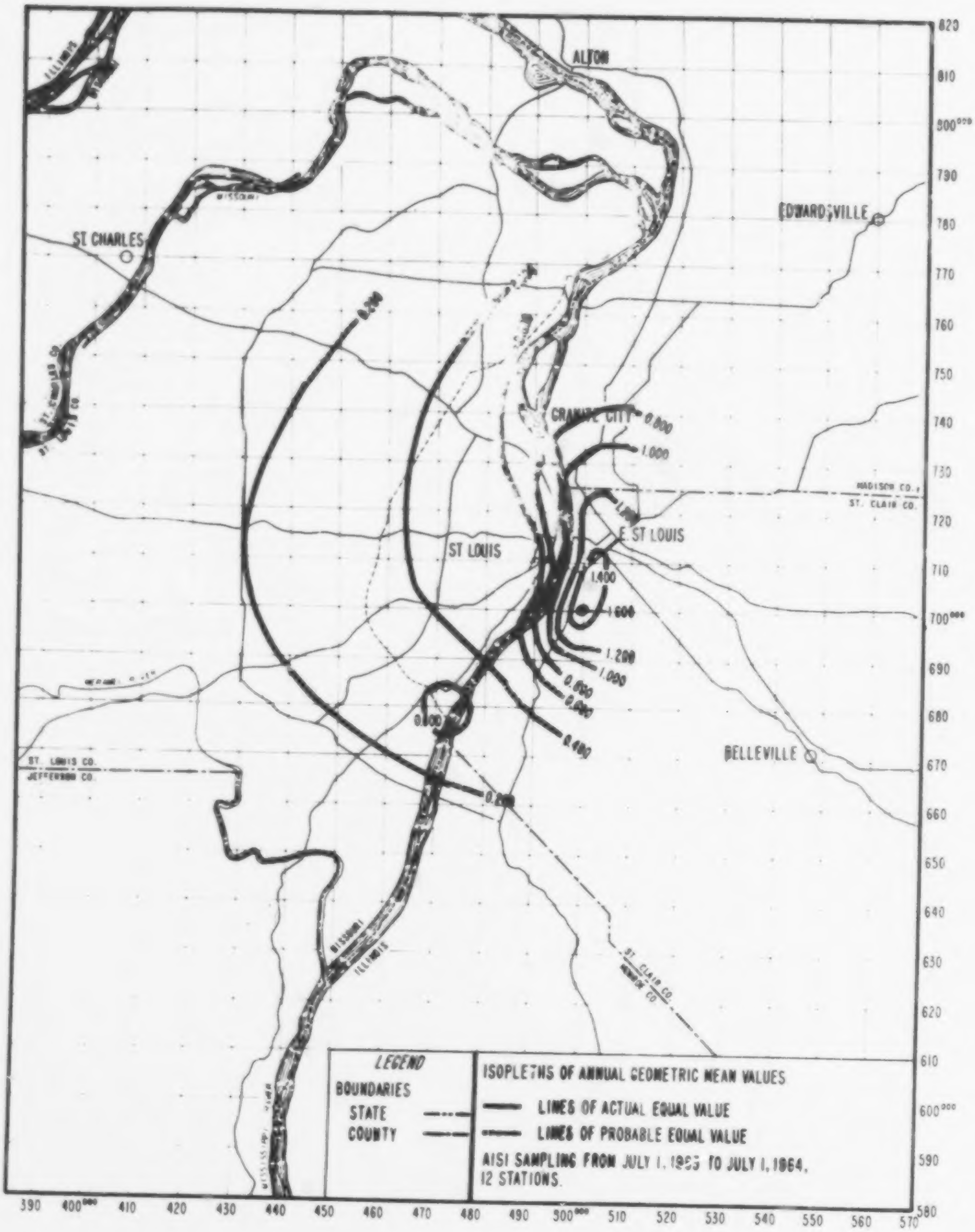
ALTON
EDWARDSVILLE
ST CHARLES
GRANITE CITY
0.800
1.000
1.200
MADISON CO.
ST. CLAIR CO.
E. ST LOUIS
ST LOUIS
1.400
1.600
1.200
1.000
0.800
0.600
0.400
0.600
0.200
0.200
BELLEVILLE
ST. LOUIS CO.
JEFFERSON CO.
MISSOURI
ILLINOIS
ST. CLAIR CO.
MONROE CO.
LEGEND
BOUNDARIES
STATE
COUNTY
ISOPLETHS OF ANNUAL GEOMETRIC MEAN VALUES
LINES OF ACTUAL EQUAL VALUE
LINES OF PROBABLE EQUAL VALUE
AISI SAMPLING FROM JULY 1, 1963 TO JULY 1, 1964, 12 STATIONS.
820
810
800
790
780
770
760
750
740
730
720
710
700
690
680
670
660
650
640
630
620
610
600
590
580
390
400
410
420
430
440
450
460
470
480
490
500
510
520
530
540
550
560
570

Figure 58. Suspended particulate annual geometric means measured with AISI sampler (Cohs/1,000 lineal ft) for 2-hour sampling.

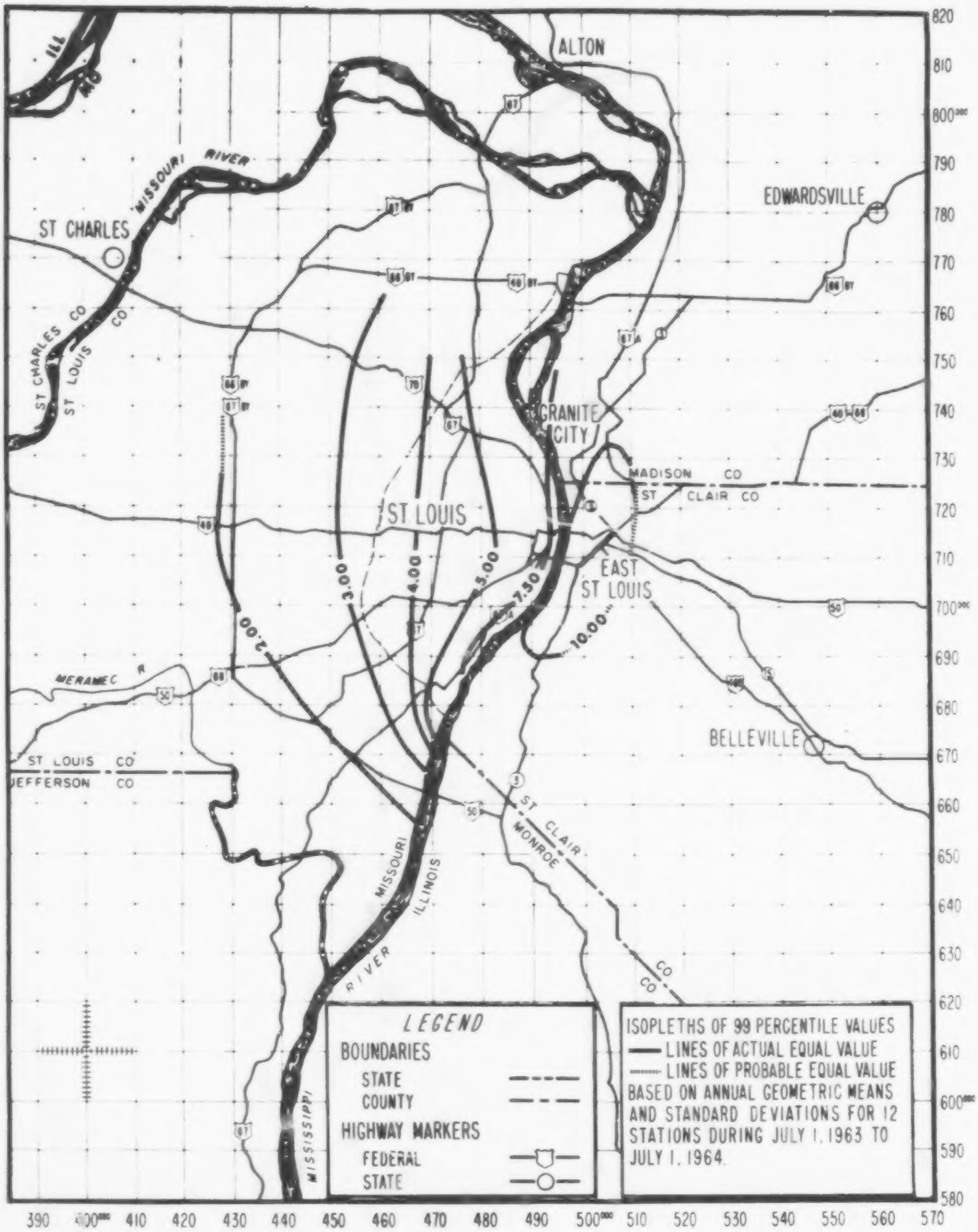
ILL
MO
ALTON
MISSOURI RIVER
ST CHARLES
EDWARDSVILLE
ST CHARLES CO
ST LOUIS CO
GRANITE CITY
MADISON CO
ST CLAIR CO
ST LOUIS
EAST ST LOUIS
2.00
3.00
4.00
5.00
7.50
10.00
MERAMEC R
BELLEVILLE
ST LOUIS CO
JEFFERSON CO
ST CLAIR
MONROE
CO
CO
MISSOURI
ILLINOIS
RIVER
MISSISSIPPI
LEGEND
BOUNDARIES
STATE
COUNTY
HIGHWAY MARKERS
FEDERAL
STATE
ISOPLETHS OF 99 PERCENTILE VALUES
LINES OF ACTUAL EQUAL VALUE
LINES OF PROBABLE EQUAL VALUE
BASED ON ANNUAL GEOMETRIC MEANS AND STANDARD DEVIATIONS FOR 12 STATIONS DURING JULY 1, 1963 TO JULY 1, 1964.
820
810
800
790
780
770
760
750
740
730
720
710
700
690
680
670
660
650
640
630
620
610
600
590
580
390
400
410
420
430
440
450
460
470
480
490
500
510
520
530
540
550
560
570

Figure 59. Suspended particulate 99 percentile values measured with AISI sampler (Cohs/1,000 lineal ft) for 2-hour sampling.

Figures 60 through 71 give the frequency distributions at each site by season and year. The geometric means and their standard deviations were used since they best described the distribution of the high-volume air sampler results and both samplers measure suspended particulates. As was found with the high-volume sampler results, the slope or standard deviation for the summer season was usually the least and the winter and fall seasons the greatest. Considering each station singly on the basis of 1 percent of the time for the year, a range of values from 1.8 to 10.3 Cohs per 1,000 lineal feet occurred. For the winter season, this range increased to 2.3 to 10.8 Cohs per 1,000 lineal feet with only 3 of 12 sites having concentrations of less than 4.0 Cohs per 1,000 lineal feet. This means that during 1 percent of the winter season, nine of the sites had "extremely heavy" concentrations according to the New Jersey rating scale.

Figure 72 is a map showing the percent of times that soiling index values equalled or exceeded 2 Cohs per 1,000 lineal feet - "heavy" according to the New Jersey rating scale. Sampling sites in St. Louis County on the edge of the air pollution basin exceeded 2 Cohs only 1 to 2 percent of the times, but the site in East St. Louis exceeded this value 68 percent of the times during the winter season.

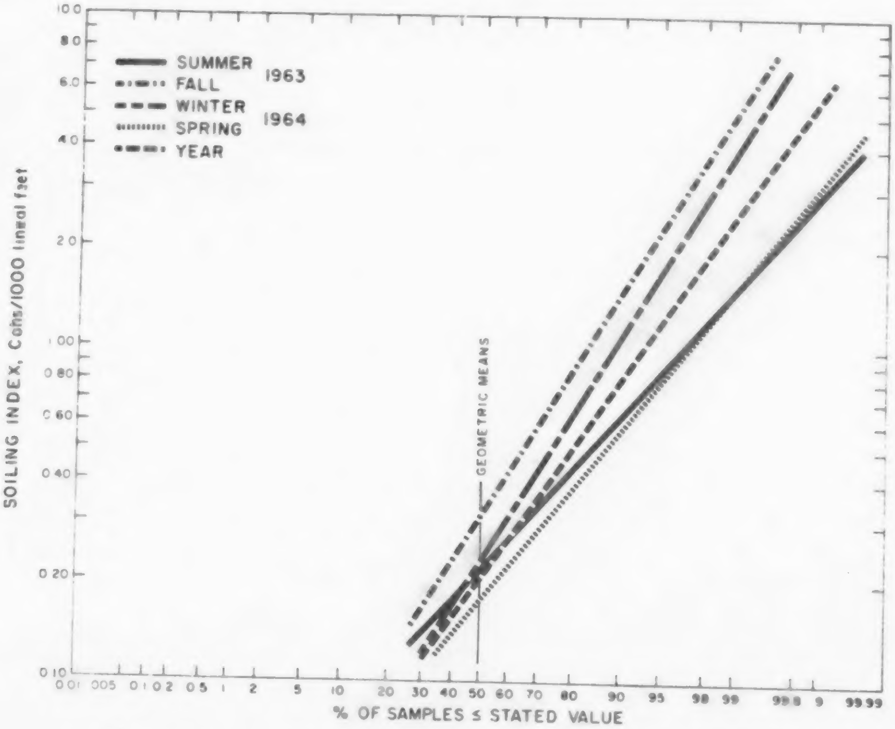

Figure 60. Frequency distribution of suspended particulates measured with AISI sampler at site No. 432-715.

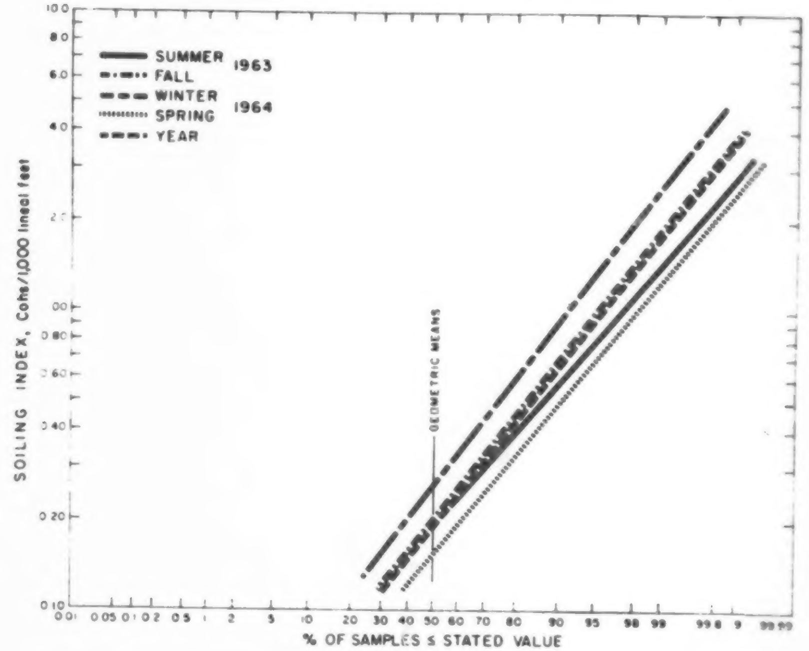

Figure 61. Frequency distribution of suspended particulates measured with AISI sampler at site No. 438-689.

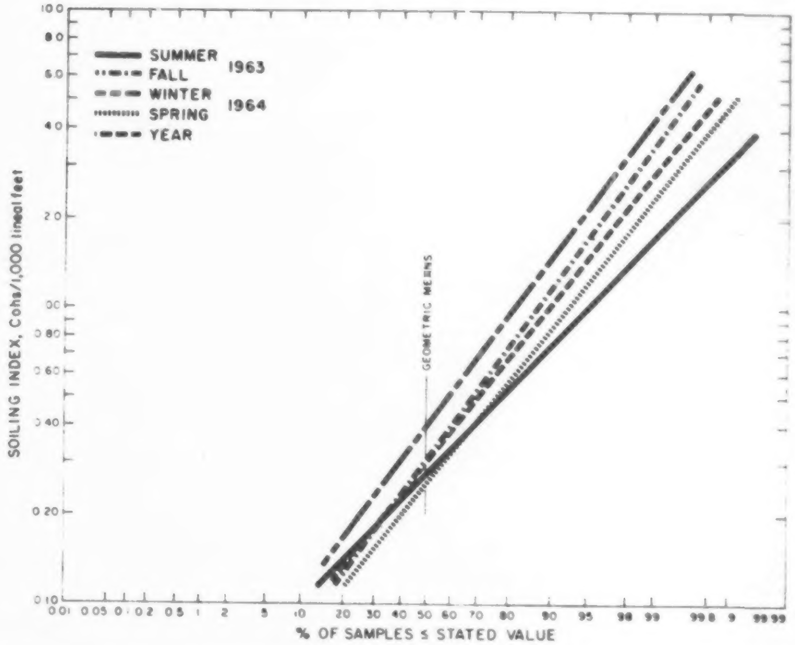

Figure 62. Frequency distribution of suspended particulates measured with AISI sampler at site No. 449-719.

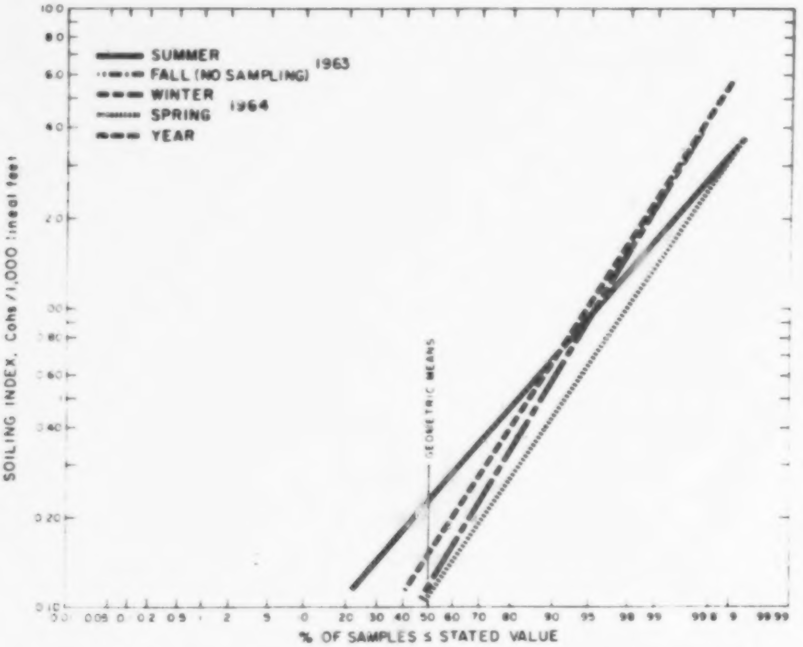

Figure 63. Frequency distribution of suspended particulates measured with AISI sampler at site No. 468-665.

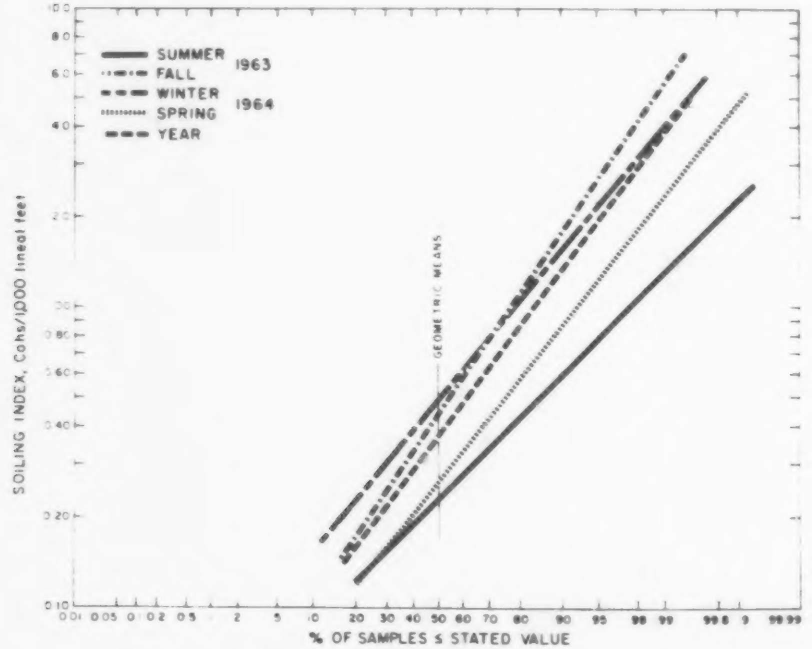

Figure 64. Frequency distribution of suspended particulates measured with AISI sampler at site No. 469-750.

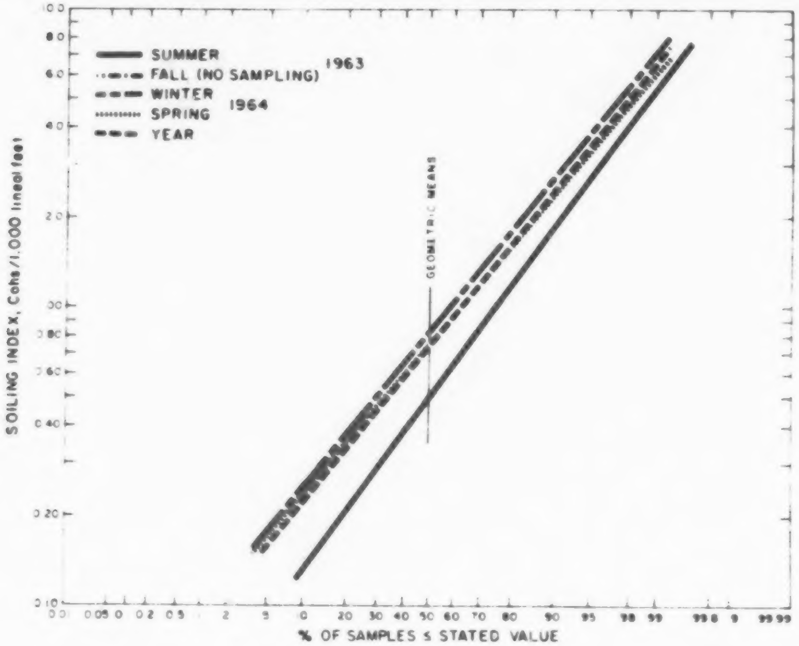

Figure 65. Frequency distribution of suspended particulates measured with AISI sampler at site No. 472-680.

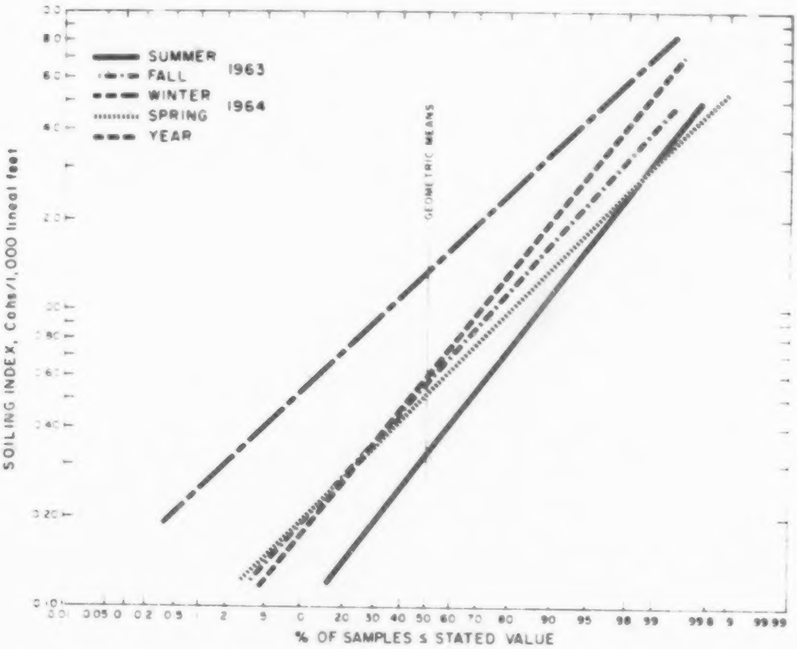

Figure 66. Frequency distribution of suspended particulates measured with AISI sampler at site No. 490-713.

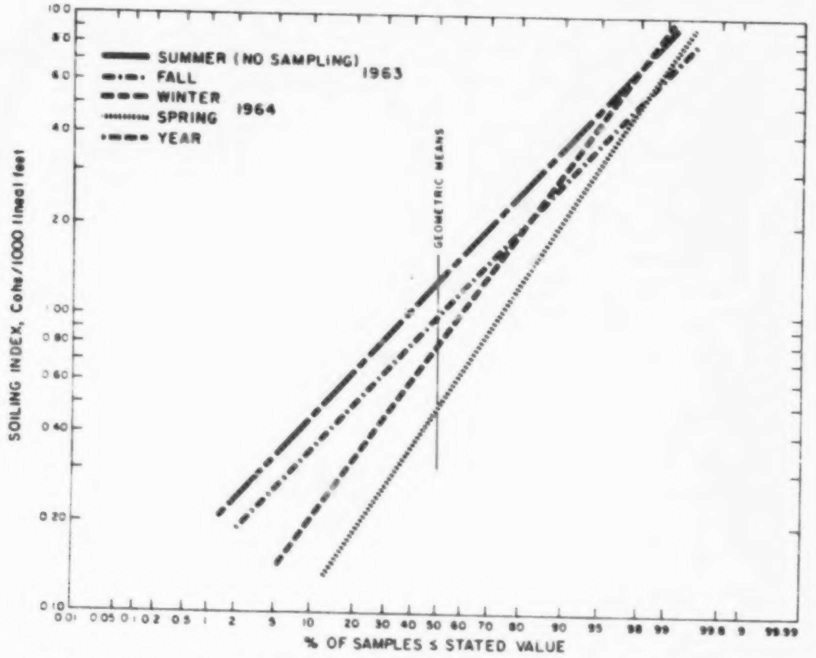

Figure 67. Frequency distribution of suspended particulates measured with AISI sampler at site No. 495-709.

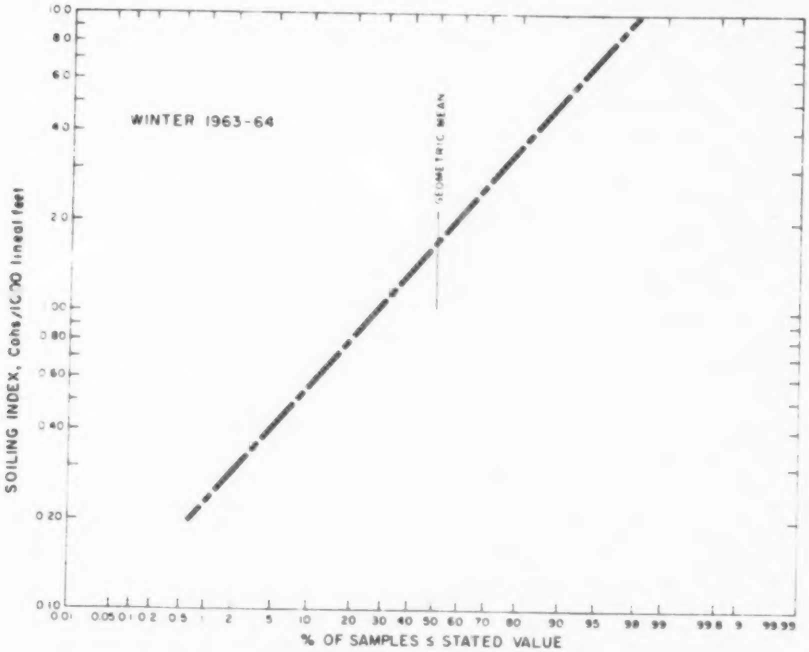

Figure 68. Frequency distribution of suspended particulates measured with AISI sampler at site No. 499-700.

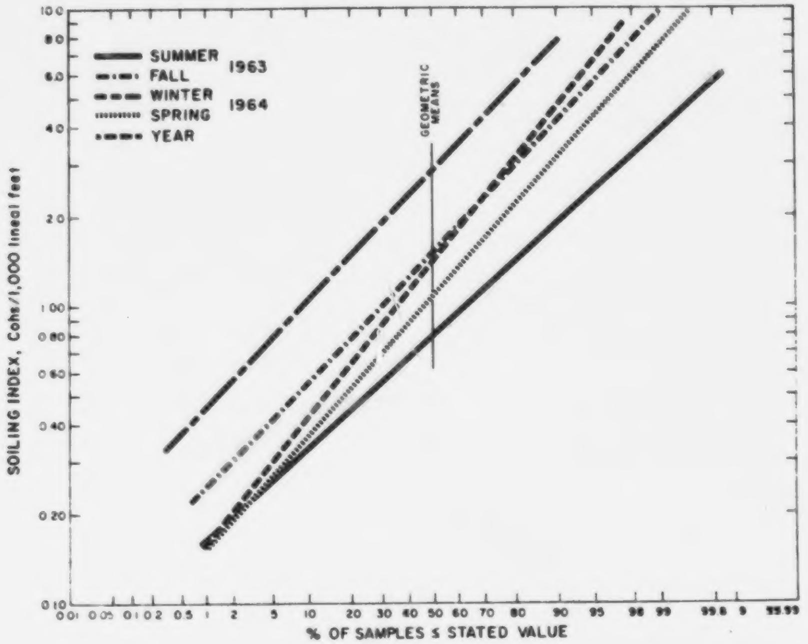

Figure 69. Frequency distribution of suspended particulates measured with AISI sampler at site No. 501-713.

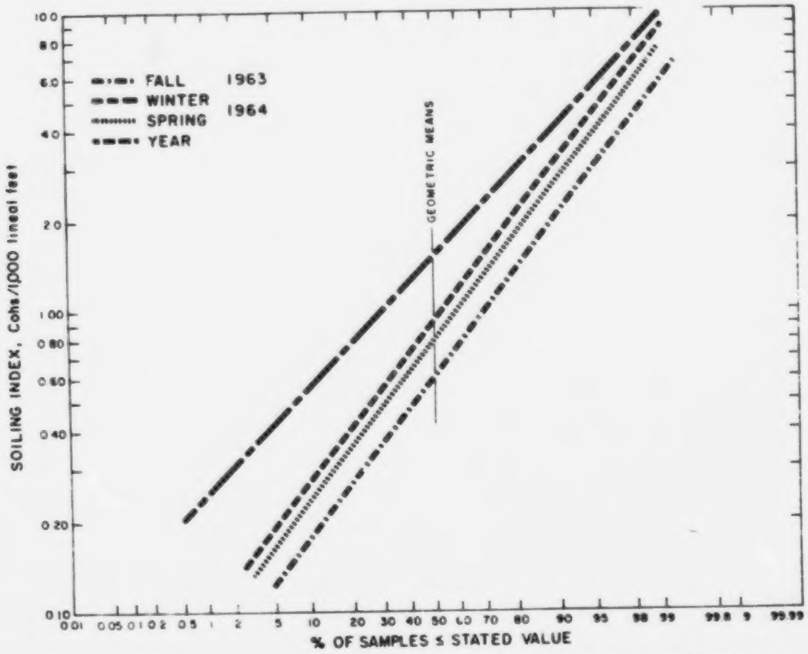

Figure 70. Frequency distribution of suspended particulates measured with AISI sampler at site No. 505-740.

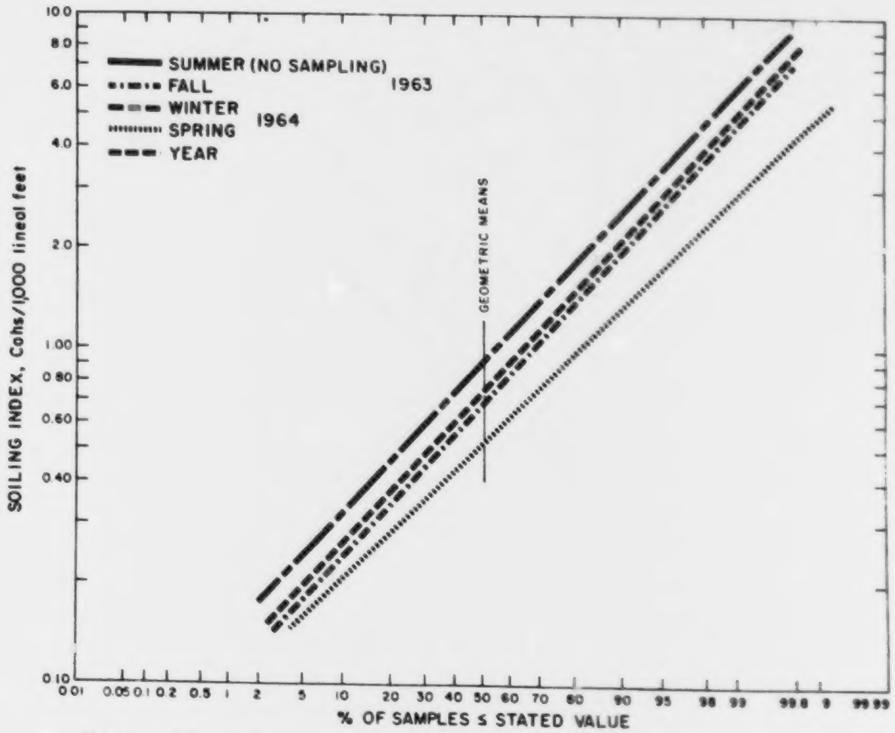

Figure 71. Frequency distribution of suspended particulates measured with AISI sampler at site No. 520-798.

The diurnal variations given in Table 22 and Figure 73 show the Coh values for the winter to be the highest, and those in the summer to be the lowest. The diurnal variations are similar to those found in other studies, i.e., the higher concentrations occur in the morning (6 to 10 a.m.) and evening (6 to 10 p.m.), and the lower occur in the early morning (2 to 6 a.m.) and afternoon (noon to 4 p.m.). The higher values are due to the increase of people's activities and to the fact that meteorological conditions are generally less favorable to dispersing pollutants at these times.

The trends of the suspended particulates by AISI sampler (Coh values, soiling index) since 1954 are shown in Table 23 and Figure 74. They show a sizeable decrease from 1954 to 1957, but only for the period April to December. This decrease does not appear in the succeeding December-to-March period. The 1957 and 1958 results appear consistent within themselves, though somewhat low in respect to the values flanking them. The missing data between 1959 and 1962 make further comparisons difficult, but it appears there has been an overall decrease since 1954 with some fluctuations in between. The decrease would seem logical since the high-volume sampler trend shows a decrease and the fuel use trend has been to convert from coal to gas and oil for heating, thus reducing the amount of particulates of this type emitted to the atmosphere.

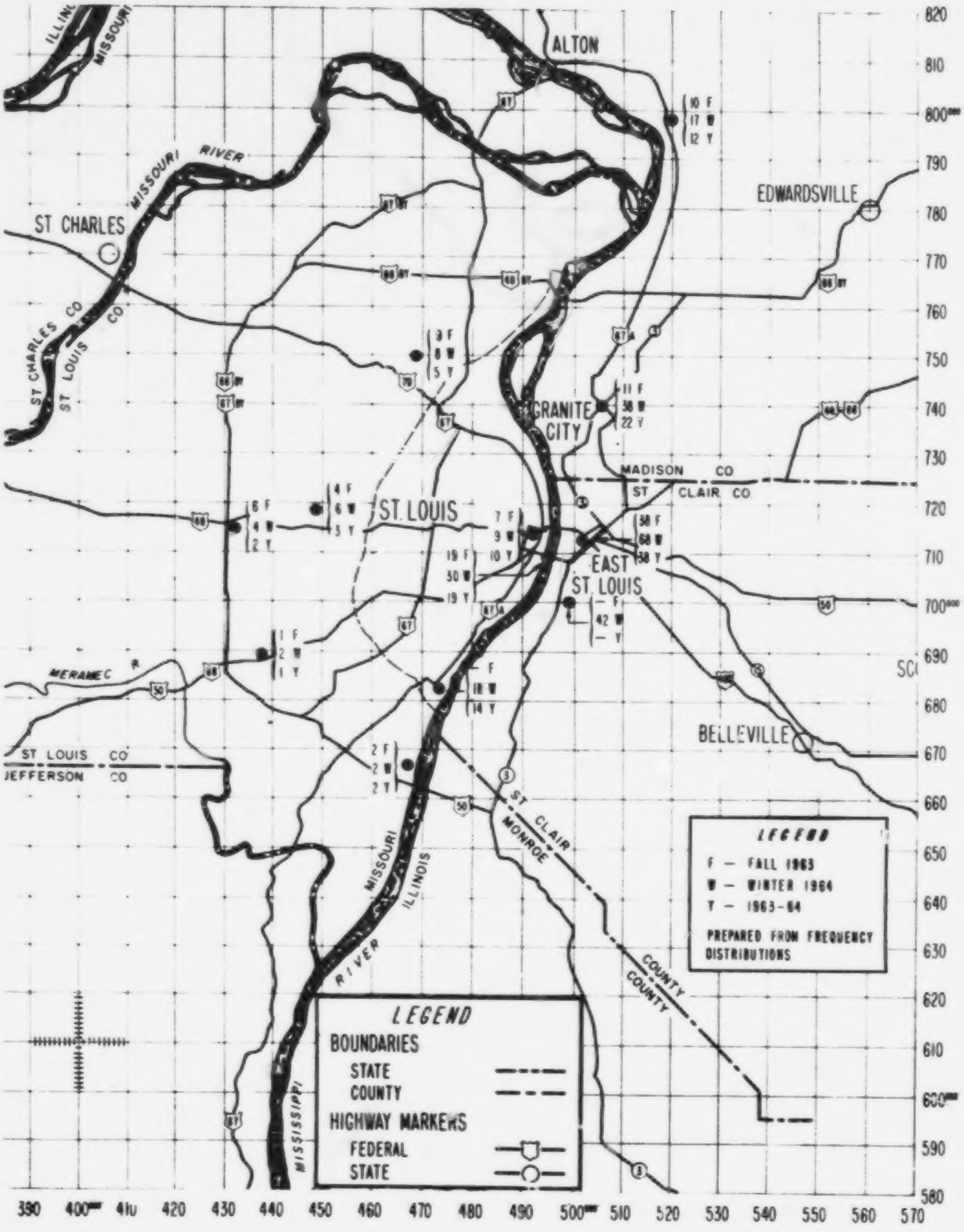
ALTON
10 F
17 W
12 Y
EDWARDSVILLE
ST CHARLES
MISSOURI RIVER
ILLINOIS
MISSOURI
ST CHARLES CO
ST LOUIS CO
3 F
8 W
5 Y
11 F
38 W
22 Y
GRANITE CITY
MADISON CO
ST CLAIR CO
6 F
4 W
2 Y
4 F
6 W
3 Y
ST. LOUIS
7 F
9 W
10 Y
19 F
30 W
19 Y
58 F
68 W
58 Y
EAST ST. LOUIS
— F
42 W
— Y
1 F
2 W
1 Y
MERAMEC R
— F
18 W
14 Y
BELLEVILLE
SC
ST LOUIS CO
JEFFERSON CO
2 F
2 W
2 Y
ST CLAIR COUNTY
MONROE COUNTY
MISSOURI
ILLINOIS
RIVER
MISSISSIPPI
LEGEND
F — FALL 1963
W — WINTER 1964
Y — 1963-64
PREPARED FROM FREQUENCY DISTRIBUTIONS
LEGEND
BOUNDARIES
STATE
COUNTY
HIGHWAY MARKERS
FEDERAL
STATE
66
67
40
70
50
3
820
810
800
790
780
770
760
750
740
730
720
710
700
690
680
670
660
650
640
630
620
610
600
590
580
390
400
410
420
430
440
450
460
470
480
490
500
510
520
530
540
550
560
570

Figure 72. Percent of times soiling index equalled or exceeded 2.0 Cohs/1,000 lineal feet.

Table 22. DIURNAL VARIATION OF AISI SAMPLER RESULTS, GEOMETRIC MEAN (Cohs/1,000 lineal feet)

Site coordinates	Date	Time of day											
		0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18	18-20	20-22	22-24
432-715	Summer '63	0.28	0.32	0.31	0.26	0.25	0.23	0.22	0.27	0.24	0.23	0.26	0.31
	Fall '63	0.50	0.47	0.58	0.43	0.27	0.26	0.21	0.28	0.37	0.40	0.45	0.53
	Winter '63-64	0.27	0.24	0.28	0.26	0.24	0.32	0.28	0.28	0.30	0.39	0.38	0.29
	Spring '64	0.25	0.25	0.20	0.19	0.17	0.16	0.17	0.18	0.18	0.19	0.27	0.29
	Year '63-64	0.27	0.25	0.25	0.23	0.21	0.22	0.21	0.21	0.23	0.26	0.31	0.30
438-689	Summer '63	0.32	0.21	0.17	0.26	0.20	0.25	0.17	0.19	0.22	0.19	0.25	0.24
	Fall '63	0.23	0.23	0.23	0.24	0.27	0.20	0.20	0.20	0.20	0.29	0.29	0.26
	Winter '63-64	0.33	0.30	0.30	0.42	0.36	0.31	0.24	0.19	0.26	0.33	0.33	0.33
	Spring '64	0.22	0.17	0.16	0.20	0.18	0.18	0.17	0.18	0.17	0.18	0.19	0.21
	Year '63-64	0.26	0.22	0.21	0.26	0.24	0.22	0.18	0.18	0.20	0.22	0.24	0.25
449-719	Summer '63	0.34	0.30	0.27	0.23	0.25	0.26	0.26	0.24	0.24	0.28	0.30	0.36
	Fall '63	0.39	0.41	0.43	0.28	0.27	0.26	0.28	0.31	0.34	0.45	0.44	0.45
	Winter '63-64	0.40	0.43	0.48	0.43	0.47	0.38	0.39	0.35	0.40	0.39	0.42	0.41
	Spring '64	0.29	0.28	0.31	0.31	0.25	0.25	0.29	0.26	0.26	0.29	0.31	0.32
	Year '63-64	0.33	0.32	0.34	0.31	0.30	0.28	0.30	0.28	0.29	0.31	0.34	0.35
468-665	Summer '63	0.28	0.31	0.28	0.28	0.28	0.29	0.30	0.30	0.29	0.25	0.27	0.28
	Winter '63-64	0.21	0.21	0.18	0.21	0.23	0.20	0.18	0.23	0.17	0.23	0.18	0.23
	Spring "64	0.21	0.13	0.19	0.26	0.16	0.16	0.15	0.17	0.22	0.16	0.24	0.22
	Year '63-64	0.24	0.22	0.21	0.25	0.24	0.22	0.19	0.23	0.20	0.23	0.21	0.25
469-750	Summer '63	0.26	0.27	0.26	0.27	0.24	0.26	0.22	0.23	0.23	0.25	0.31	0.29
	Fall '63	0.47	0.43	0.42	0.45	0.52	0.43	0.34	0.29	0.38	0.63	0.63	0.61
	Winter '63-64	0.50	0.43	0.44	0.56	0.61	0.51	0.39	0.37	0.49	0.64	0.57	0.52
	Spring '64	0.29	0.28	0.26	0.32	0.34	0.31	0.26	0.21	0.23	0.27	0.33	0.33
	Year '63-64	0.40	0.38	0.36	0.43	0.47	0.40	0.33	0.29	0.35	0.46	0.47	0.44
472-680	Summer '63	0.66	0.56	0.47	0.68	0.51	0.72	0.46	0.58	0.54	0.52	0.65	0.55
	Winter '63-64	0.91	0.81	0.74	0.85	0.99	1.04	1.01	0.70	0.81	0.93	0.90	0.85
	Spring '64	0.83	0.66	0.68	0.80	0.82	0.87	0.72	0.81	0.78	0.81	0.84	0.71
	Year '63-64	0.88	0.70	0.69	0.82	0.85	0.92	0.78	0.75	0.74	0.83	0.85	0.74
490-713	Summer '63	0.40	0.33	0.44	0.58	0.48	0.33	0.28	0.29	0.33	0.34	0.40	0.51
	Fall '63	0.56	0.46	0.58	0.78	1.01	0.53	0.36	0.41	0.48	0.59	0.68	0.68
	Winter '63-64	1.30	0.37	1.26	1.44	1.40	1.28	1.15	1.24	1.47	1.41	1.39	1.22
	Spring '64	0.60	0.58	0.58	0.62	0.52	0.50	0.51	0.47	0.54	0.56	0.57	0.57
	Year '63-64	0.66	0.64	0.68	0.76	0.73	0.56	0.49	0.49	0.59	0.59	0.69	0.68
495-709	Fall '63	0.86	0.82	0.93	1.12	1.15	0.88	0.73	0.78	1.08	1.21	1.17	1.06
	Winter '63-64	1.02	1.01	0.98	1.22	1.59	1.54	1.06	1.04	1.21	1.54	1.26	1.13
	Spring '64	0.63	0.55	0.69	0.69	0.58	0.63	0.49	0.46	0.52	0.55	0.54	0.63
	Year '63-64	0.81	0.76	0.83	0.92	1.00	0.95	0.71	0.71	0.82	0.96	0.89	0.90
499-700	Winter '63-64	1.47	2.30	2.06	1.82	1.75	1.70	1.36	1.60	1.70	1.37	1.39	1.60
501-713	Summer '63	0.83	0.80	0.92	1.12	0.86	0.72	0.53	0.53	0.63	0.71	1.00	0.94
	Fall '63	1.57	1.39	1.54	1.96	1.97	1.29	0.95	1.00	1.43	1.84	1.82	1.73
	Winter '63-64	2.32	2.32	2.66	4.21	4.12	2.73	2.05	2.10	2.92	3.31	3.13	2.72
	Spring '64	1.24	1.04	1.15	1.65	1.38	1.03	0.74	0.72	0.83	1.12	1.31	1.29
	Year '63-64	1.39	1.28	1.46	2.03	1.79	1.27	0.93	0.95	1.21	1.48	1.67	1.56
505-740	Fall '63	0.66	0.71	0.64	0.71	0.79	0.79	0.63	0.47	0.47	0.53	0.65	0.83
	Winter '63-64	1.59	1.48	1.59	2.04	1.96	1.60	1.28	1.18	1.30	1.49	1.64	1.74
	Spring '64	0.87	0.82	0.93	0.96	0.90	0.79	0.68	0.78	0.74	0.95	0.85	0.88
	Year '63-64	0.96	0.92	1.00	1.12	1.09	0.94	0.80	0.78	0.78	0.94	0.95	1.04
520-798	Fall '63	0.61	0.72	0.64	0.71	0.85	0.75	0.64	0.47	1.44	0.61	0.75	0.73
	Winter '63-64	0.94	0.90	0.72	0.90	1.40	1.26	0.91	0.73	0.67	0.82	0.81	0.92
	Spring '64	0.69	0.61	0.55	0.40	0.85	0.79	0.64	0.28	0.44	0.37	0.52	0.48
	Year '63-64	0.68	0.75	0.65	0.73	0.97	0.85	0.70	0.50	0.48	0.61	0.73	0.74
ALL	Summer '63	0.40	0.37	0.36	0.39	0.35	0.34	0.30	0.30	0.31	0.33	0.39	0.42
	Fall '63	0.63	0.61	0.63	0.67	0.71	0.56	0.45	0.45	0.52	0.69	0.72	0.72
	Winter '63-64	0.64	0.61	0.63	0.74	0.79	0.69	0.56	0.55	0.63	0.75	0.70	0.67
	Spring '64	0.45	0.40	0.41	0.46	0.42	0.39	0.35	0.34	0.36	0.40	0.45	0.46
	Year '63-64	0.53	0.49	0.50	0.57	0.55	0.49	0.41	0.41	0.45	0.52	0.55	0.55

Table 23. TREND OF SUSPENDED PARTICULATES BY AISI SAMPLER[a]
(Cohs/1,000 lineal feet)

Year	Ref.	April				May				June				July				August				September			
		00	06	12	18	00	06	12	18	00	06	12	18	00	06	12	18	00	06	12	18	00	06	12	18
1954-55	63	1.7	2.3	1.2	1.4	1.6	2.0	0.7	0.7	1.0	1.2	0.6	0.8	1.1	1.3	0.8	0.7	0.7	1.1	0.5	0.5	0.8	1.1	0.6	0.7
1957-58	63	0.5	0.6	0.4	0.5	0.4	0.4	0.3	0.3	-	-	-	-	0.4	0.4	0.3	0.3	0.4	0.5	0.3	0.3	0.4	0.5	0.4	0.5
1958-59	64	0.6	1.0	0.4	0.5	0.5	0.5	0.4	0.4	0.5	0.4	0.2	0.2	0.6	0.8	0.5	0.4	0.8	1.0	0.6	0.6	1.0	1.0	0.6	0.6
1962-63	65	0.9	1.1	0.6	0.7	0.7	0.7	0.8	0.9	0.7	0.7	0.4	0.4	0.5	0.6	0.4	0.3	0.6	0.8	0.3	0.5	0.5	0.6	0.4	0.1
Aug.'63 to		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.4	0.6	0.3	0.3	0.6	0.8	0.4	0.6
July '64		0.6	0.6	0.6	0.6	0.5	0.6	0.4	0.5	0.6	0.6	0.4	0.3	-	-	-	-	-	-	-	-	-	-	-	-

Year	Ref.	October				November				December				January				February				March			
		00	06	12	18	00	06	12	18	00	06	12	18	00	06	12	18	00	06	12	18	00	06	12	18
1954-55	63	1.2	1.8	0.9	1.4	1.8	2.0	1.6	2.1	1.6	1.0	1.7	1.9	1.5	2.1	1.8	2.0	1.7	2.0	1.6	2.1	1.5	1.9	1.2	1.6
1957-58	63	0.7	0.8	0.6	0.7	1.0	1.2	0.8	1.0	1.3	1.0	1.0	1.2	1.5	1.9	1.0	1.6	1.0	1.5	1.3	1.5	1.0	0.0	0.5	1.0
1958-59	64	1.4	1.5	1.0	1.3	1.7	1.9	1.5	2.0	1.8	2.0	1.8	2.0	1.7	2.3	1.7	1.8	1.4	1.9	1.7	1.6	1.0	1.0	0.7	0.9
1962-63	65	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.0	1.1	0.9	1.1	0.8	0.9	0.8	0.7
Aug.'63 to		-	-	-	-	-	-	-	-	-	-	-	-												
July '64		-	-	-	-	-	-	-	-	-	-	-	-	1.3	1.5	1.2	1.3	1.4	1.3	1.1	1.6	-	-	-	-

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[a] The data from 1954 - 1963 are 3-hour samples from site 491-713. Data from August 1963 - July 1964 are 2-hour samples reported as geometric means from site 490-713.

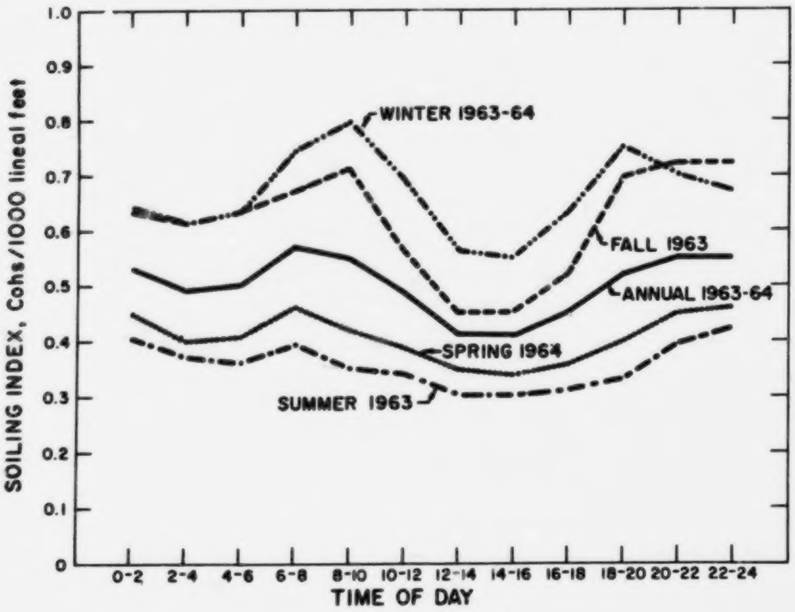


Figure 73. Diurnal variation of soiling index geometric means - all AISI sampler sites.

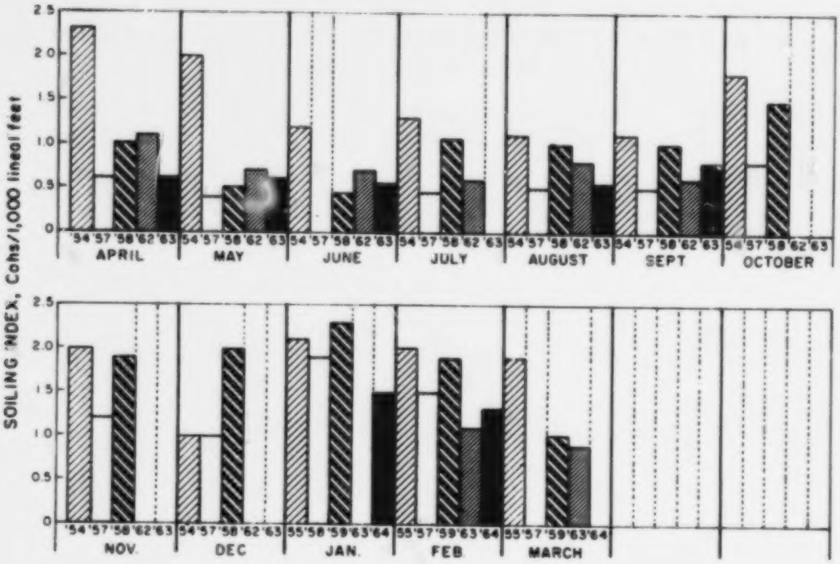


Figure 74. Suspended particulates - 6 a.m. monthly means - AISI sampler.

Pollution roses for each site for February 1964 are given in Figures 75 through 84. February was selected as the period for analysis because more samplers were operating at that time than during any other period of the study. Mechanical problems led to redesign and rebuilding of every sampler. Data from rebuilt units are far more reliable than those from original equipment. The redesign features are reported in Memorandum of Information and Instruction Number 8, AISI Tape Sampler Modifications.

Figure 85 shows the wind directions for the three highest AISI suspended particulate directional averages at each station during February 1964. It indicates that for the stations in Missouri, away from the central metropolitan area, the highest suspended particulates occurred when the wind was from the direction of the central metropolitan area. The wind direction - particulate level relationships shown in Figure 85 and the pollution roses at sites 505-740 and 472-680 are due to point sources.

For the stations in East St. Louis and the St. Louis central business district, the actual wind directions are at times markedly different from those at the Weather Bureau station at Lambert Field; therefore, the actual wind directions for the maximum particulate levels in these areas may not be quite as indicated. The altered wind directions were reported by Arnold[15] to be caused by counterflow of air close to the ground surface and to air drift along the valley because of the channel-

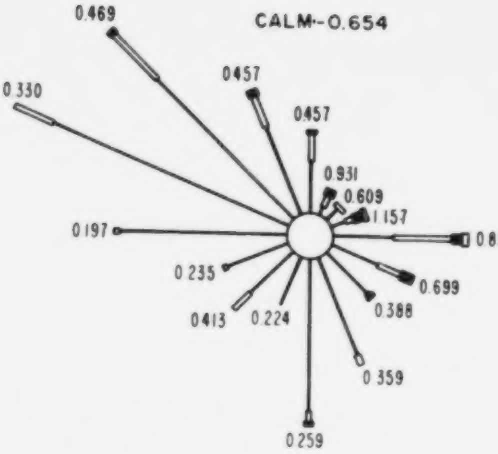


Figure 75. Soiling index pollution rose - site No. 432-715 345 samples.

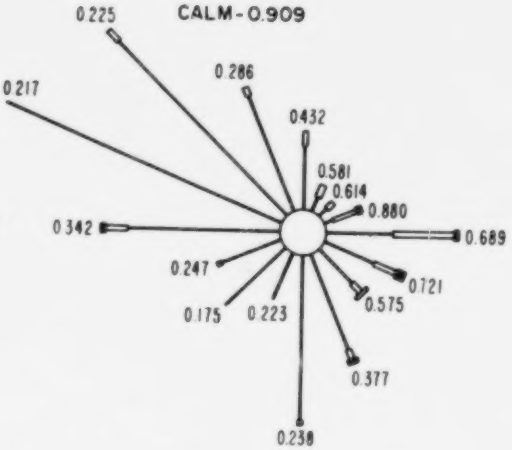
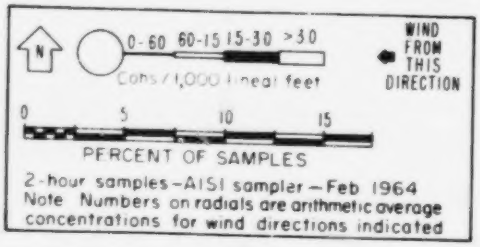


Figure 76. Soiling index pollution rose - site No. 438-689 347 samples.


N
0-60
60-15
15-30
>3.0
Cons/1,000 lineal feet
WIND FROM THIS DIRECTION
0
5
10
15
PERCENT OF SAMPLES
2-hour samples-AISI sampler-Feb 1964
Note Numbers on radials are arithmetic average concentrations for wind directions indicated

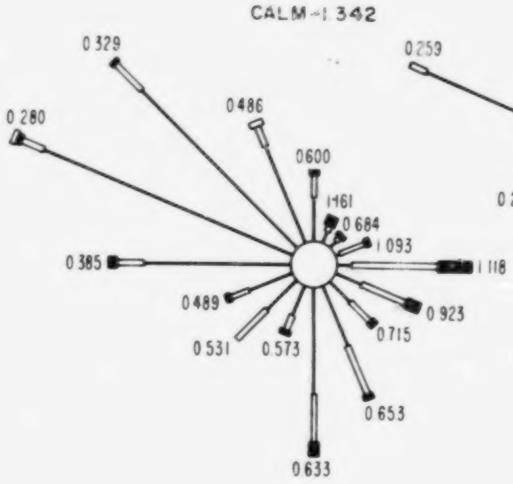


Figure 77. Soiling index pollution rose - site No. 449-347 347 samples.

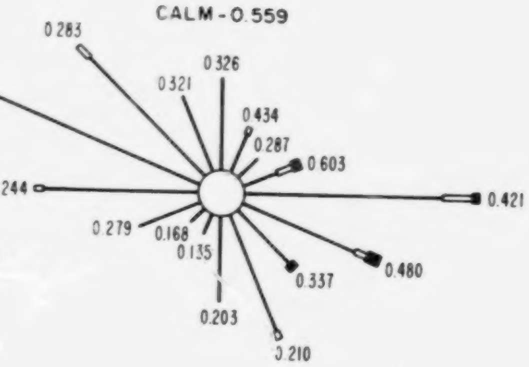


Figure 78. Soiling index pollution rose - site No. 468-665 192 samples.

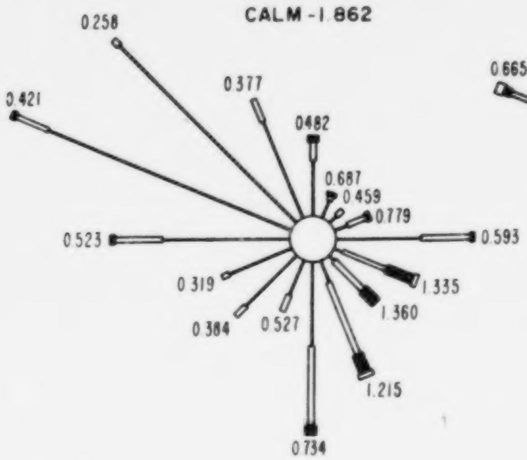


Figure 79. Soiling index pollution rose - site No. 469-750 348 samples.

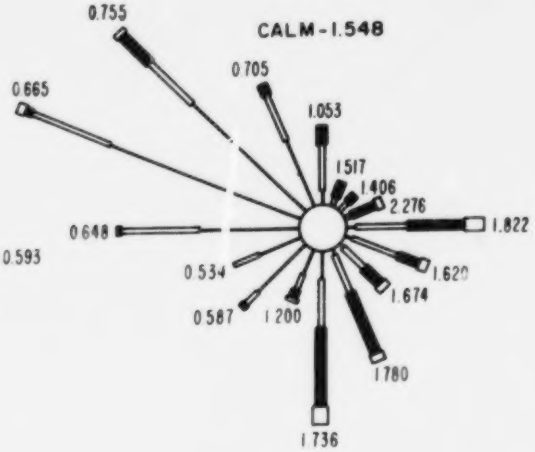
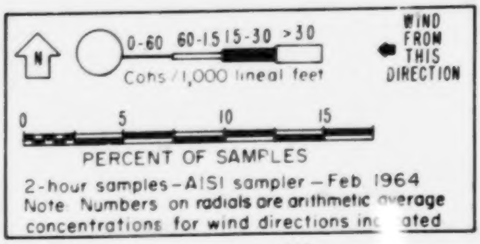


Figure 80. Soiling index pollution rose - site No. 472-680 348 samples.


N
0-60
60-15
15-30
>30
Cohs/1,000 lineal feet
WIND FROM THIS DIRECTION
0
5
10
15
PERCENT OF SAMPLES
2-hour samples–AISI sampler–Feb 1964
Note: Numbers on radials are arithmetic average concentrations for wind directions indicated

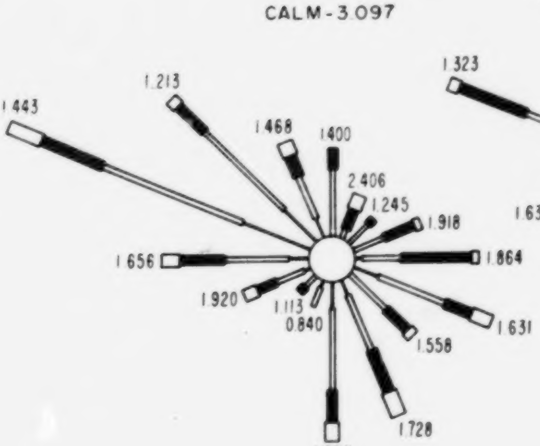


Figure 81. Soiling index pollution rose - site No. 490-713 196 samples.

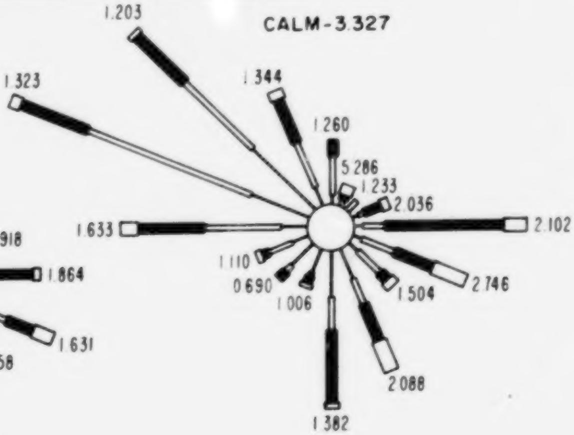


Figure 82. Soiling index pollution rose - site No. 495-709 249 samples.

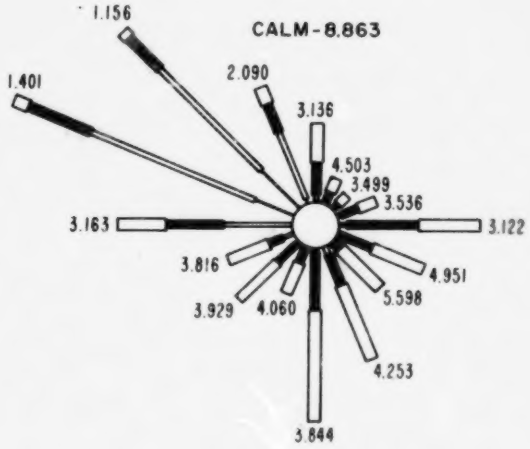
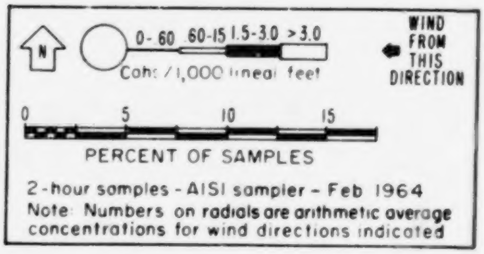


Figure 83. Soiling index pollution rose - site No. 501-713 342 samples.


N
0-.60
.60-1.5
1.5-3.0
>3.0
Cohs/1,000 lineal feet
WIND FROM THIS DIRECTION
0
5
10
15
PERCENT OF SAMPLES
2-hour samples - AISI sampler - Feb 1964
Note: Numbers on radials are arithmetic average concentrations for wind directions indicated

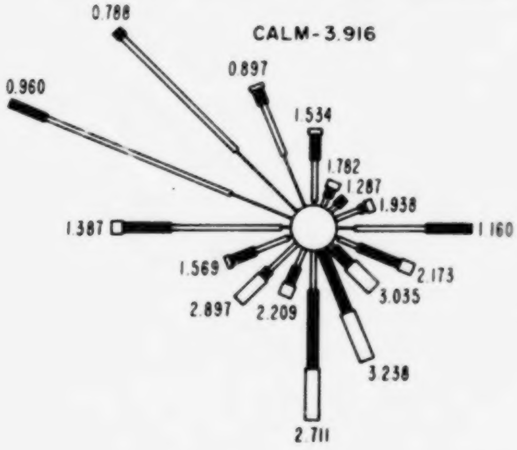


Figure 84. Soiling index pollution rose - site No. 505-740 348 samples.

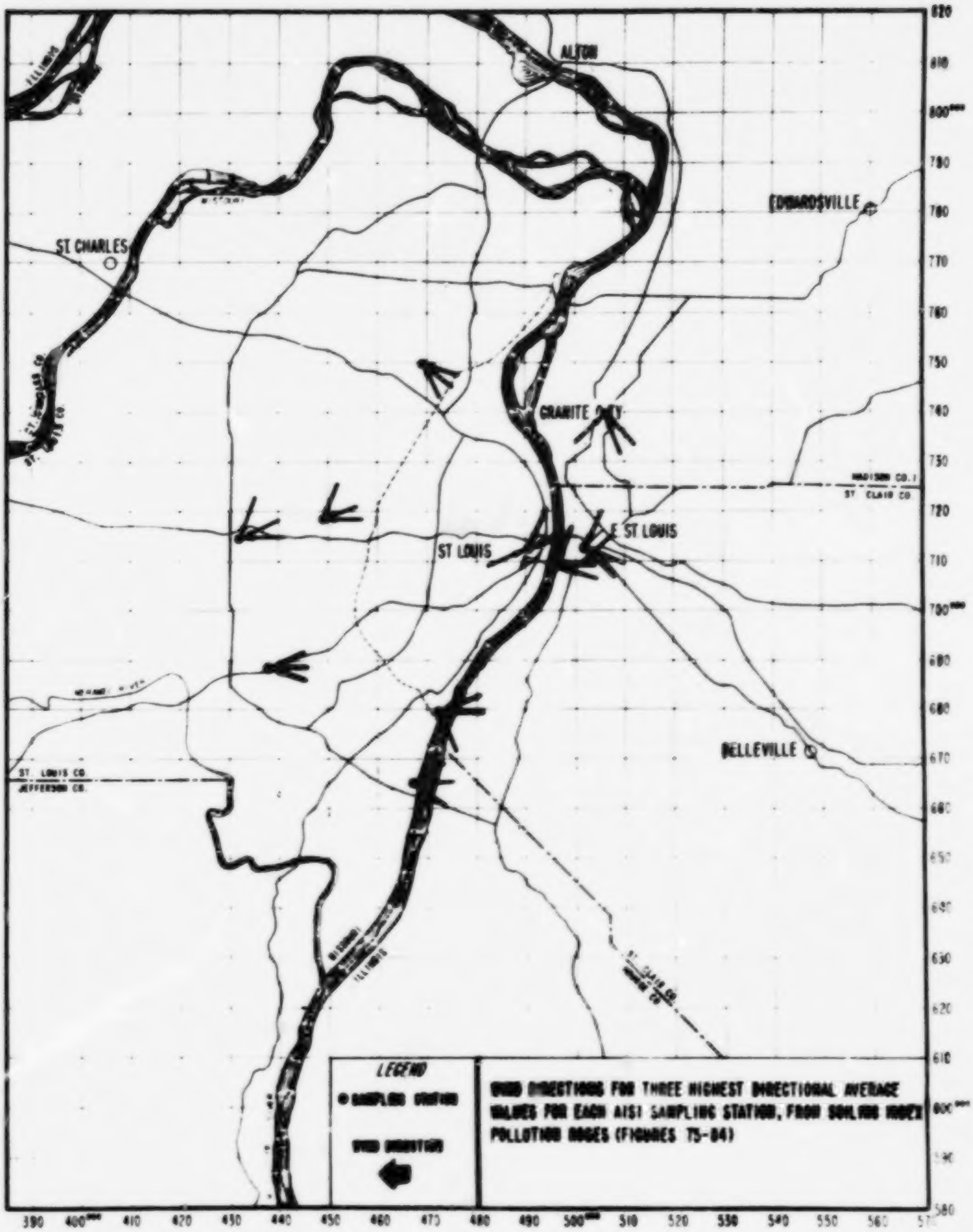

ALTON
EDWARDSVILLE
ST CHARLES
GRANITE CITY
ST LOUIS
E ST LOUIS
BELLEVILLE
ILLINOIS
MISSOURI
ST. CHARLES CO.
ST. LOUIS CO.
JEFFERSON CO.
MADISON CO.
ST. CLAIR CO.
LEGEND
SAMPLING STATION
WIND DIRECTION
WIND DIRECTIONS FOR THREE HIGHEST DIRECTIONAL AVERAGE VALUES FOR EACH AISI SAMPLING STATION, FROM SOILING INDEX POLLUTION ROSES (FIGURES 75-84)
820
810
800
790
780
770
760
750
740
730
720
710
700
690
680
670
660
650
640
630
620
610
600
590
580
390
400
410
420
430
440
450
460
470
480
490
500
510
520
530
540
550
560
570

Figure 85. AISI suspended particulate high values by wind direction.

ing effect. The counterflow and drift are verified and quantitated to some degree by wind measurements at the different levels on the KMOX-TV tower. They are reported in Volume V, Meteorology and Topography.

The results of the correlation between meteorological stability classes and the AISI sampler data for each site are given in Table 24. At 6 of the 12 sites the results have the same pattern as the high-volume sampler results, a decrease in suspended particulates from class 2 to class 4 and an increase for class 5. Four of the six sites not having this pattern had an increase from class 2 to 3, but a decrease from class 3 to 4, and an increase from class 4 to 5. The other two sites showed increases from class 3 to 4. These results indicate that although wind speed is the more influential factor, thermal mixing has a greater influence on particulates collected by the AISI sampler than on that collected by the high-volume air sampler. The difference reflects the influence of the smaller particles collected by the AISI sampler. The class 1 condition did not occur during February 1964.

Table 24. AVERAGE SUSPENDED PARTICULATES BY AISI SAMPLER FOR FIVE ATMOSPHERIC STABILITY CLASSES, WINTER 1963-64
(Cohs/1,000 lineal feet)

Site coordinates	Atmospheric stability class[a]				
	1	2	3	4	5,6,7
432-715	-	0.359	0.358	0.405	0.400
438-689	-	0.325	0.419	0.343	0.471
449-719	-	0.917	0.735	0.472	0.773
468-665	-	0.318	0.193	0.220	0.217
469-750	-	0.963	0.897	0.550	0.877
472-680[b]	-	1.409	1.346	1.065	1.196
490-713[c]	-	1.986	2.030	1.436	1.971
495-709	-	2.028	2.294	1.532	1.808
499-700	-	3.880	2.599	1.959	2.346
501-713	-	4.763	4.632	2.785	5.075
505-740[c]	-	2.328	2.121	1.618	2.621
520-798	-	0.740	1.971	1.022	1.296

[a] 1 = extremely unstable.
2 = unstable.
3 = slightly unstable.
4 = neutral.
5,6,7 = slightly stable, stable, and extremely stable.

[b] Feb 1964 only.

[c] Jan and Feb 1964 only.

SULFATION

Lead peroxide candles were located at 42 sites to measure sulfation rates. The results are reported in milligrams of sulfur trioxide per 100 square centimeters per day and are given in Tables 25 to 30. The results ranged from 0.10 to 8.86 mg $SO_3/100\ cm^2/day$ for the period March 1963 through February 1964. The arithmetic mean for all sites during this period was 1.228 mg $SO_3/100\ cm^2/day$, and the geometric mean was 0.886 mg $SO_3/100\ cm^2/day$. Site 433-565, which is a low-population-density residential-to-rural site, had the lowest yearly geometric mean of 0.220 mg $SO_3/100\ cm^2/day$, and site 472-680, which is heavily industrialized, had the highest of 5.264 mg $SO_3/100\ cm^2/day$.

The monthly and seasonal trends are shown in Figure 86. With the exception of the increase in July and August, these trends follow those found in Nashville.[2] The July and August anomaly was examined by plotting individual June-to-July increases for each station on a map. This was done in two ways, with both showing essentially the same results. The first was based on the hypothesis that the pollutant would be uniformly distributed over the area and that it would cause an increase of at least 0.15 mg $SO_3/100\ cm^2/day$. The second assumed a pollutant distribution that would cause a 20 percent or more increase from the June value. The map, Figure

Table 25. 1963-64 SULFATION FOR ALL STATIONS BY MONTHS
(mg $SO_3/100\ cm^2/day$)

Month	Minimum	Maximum	N[a]	Arithmetic Mean	Arithmetic Standard deviation	Geometric Mean	Geometric Standard deviation
Feb 1963	0.17	3.58	29	1.301	0.746	1.103	1.859
Mar	0.19	4.63	38	1.365	0.955	1.086	2.044
Apr	0.20	7.27	39	1.153	1.275	0.857	2.021
May	0.16	5.52	40	0.909	0.999	0.649	2.168
June	0.13	4.32	39	0.734	0.819	0.517	2.214
July	0.16	8.86	38	1.378	1.758	0.827	2.634
Aug	0.20	4.77	40	0.887	0.882	0.671	2.018
Sept	0.14	4.33	40	0.814	0.767	0.617	2.055
Oct	0.15	6.54	40	1.159	1.116	0.852	2.193
Nov	0.10	7.04	41	1.400	1.208	1.046	2.231
Dec	0.42	4.17	41	1.694	1.040	1.405	1.880
Jan 1964	0.13	4.85	40	1.729	1.142	1.366	2.136
Feb	0.28	3.94	41	1.499	0.957	1.233	1.913

[a] N = number of samples.

Table 26. SULFATION FOR MARCH, APRIL, MAY 1963
($mg\ SO_3/100\ cm^2/day$)

Site coordinates	Minimum	Maximum	N[a]	Arithmetic		Geometric	
				Mean	Standard deviation	Mean	Standard deviation
407-770	0.22	0.47	3	0.370	0.132	0.351	1.506
421-729	0.16	0.46	3	0.333	0.155	0.308	1.755
433-565	0.19	0.22	3	0.203	0.015	0.202	1.077
435-589	0.19	0.42	3	0.333	0.125	0.314	1.549
435-717	0.24	0.40	3	0.326	0.080	0.319	1.298
436-743	0.38	0.80	3	0.580	0.210	0.554	1.451
449-719	0.43	0.43	1				
451-728	0.41	0.93	3	0.666	0.260	0.631	1.508
453-701	0.33	0.93	3	0.606	0.302	0.555	1.678
457-766	0.33	0.79	3	0.580	0.232	0.544	1.569
463-691	0.59	1.05	3	0.793	0.234	0.771	1.336
464-740	0.63	1.19	3	0.883	0.283	0.853	1.375
465-731	0.67	3.42	3	1.846	1.417	1.492	2.260
467-758	0.47	1.02	3	0.713	0.280	0.677	1.475
469-683	0.71	1.27	3	1.046	0.295	1.015	1.367
469-705	0.82	1.45	3	1.080	0.329	1.048	1.340
469-749	0.45	1.08	3	0.750	0.316	0.704	1.549
471-714	0.81	1.64	3	1.203	0.416	1.155	1.422
472-680	5.52	7.27	2	6.395	1.237	6.334	1.214
476-724	0.84	1.79	3	1.296	0.476	1.237	1.460
477-758	0.50	1.08	3	0.830	0.298	0.789	1.498
479-704	1.00	1.52	3	1.233	0.264	1.214	1.234
482-699	0.66	0.96	3	0.833	0.155	0.823	1.216
488-672	0.42	0.74	3	0.550	0.168	0.534	1.340
490-646	0.29	0.47	3	0.386	0.090	0.379	1.278
490-713	1.38	1.38	1				
490-730	1.04	1.75	3	1.393	0.355	1.362	1.297
495-693	0.66	0.78	3	0.710	0.062	0.708	1.090
495-809	0.84	1.35	3	1.013	0.291	0.987	1.310
498-704	3.88	4.89	3	4.466	0.524	4.445	1.128
499-724	1.37	2.93	3	2.063	0.794	1.964	1.464
501-713	1.31	1.31	1				
505-741	0.48	2.77	3	1.760	1.168	1.392	2.547
509-710	1.22	2.03	3	1.656	0.408	1.621	1.296
517-692	1.30	2.98	3	1.876	0.955	1.735	1.597
517-762	0.53	1.98	3	1.086	0.781	0.923	1.980
520-790	0.96	1.67	3	1.320	0.355	1.287	1.320
521-725	1.33	1.92	3	1.546	0.324	1.525	1.221
554-668	0.22	0.82	3	0.510	0.300	0.445	1.940
585-683	0.31	0.63	3	0.450	0.163	0.431	1.429
All	0.16	7.27	117	1.138	1.093	0.841	2.129

[a] N = number of samples.

87, shows that the central portion of the Study area, including East St. Louis and the central portion of St. Louis, was not affected by this summertime phenomenon. The urban area surrounding the central area was affected except for an area to the east of East St. Louis. Since most outlying stations in Belleville, St. Louis County, Jefferson County, St. Clair County, and St. Charles County did not show an appreciable July increase, this phenomenon is apparently associated with some activity in the major urban areas. The 1,400 percent increase at station 488-672 in the southeast part of the study area near large swampy areas suggested that anaerobic

Table 27. SULFATION FOR JUNE, JULY, AUGUST 1963 (mg SO_3/100 cm^2/day)

Site coordinates	Minimum	Maximum	N[a]	Arithmetic		Geometric	
				Mean	Standard deviation	Mean	Standard deviation
407-740			0				
421-729	0.18	0.34	3	0.256	0.080	0.248	1.374
433-565	0.13	0.28	3	0.190	0.079	0.179	1.487
435-589	0.32	0.34	3	0.330	0.009	0.329	1.030
435-717	0.13	0.25	3	0.200	0.062	0.192	1.414
436-743	0.31	0.41	3	0.360	0.050	0.357	1.150
449-719	0.33	0.51	3	0.420	0.090	0.413	1.243
451-728	0.30	0.48	3	0.383	0.090	0.376	1.265
453-701	0.19	0.38	3	0.303	0.100	0.290	1.451
457-766	0.30	0.41	2	0.355	0.077	0.350	1.247
463-691	0.47	0.79	3	0.656	0.166	0.641	1.315
464-740	0.44	4.10	3	1.716	2.065	1.032	3.338
465-731	0.49	0.75	3	0.626	0.130	0.617	1.240
467-758	0.32	0.55	3	0.436	0.115	0.426	1.312
469-683	0.62	0.90	3	0.780	0.144	0.770	1.214
469-705	0.30	0.95	3	0.683	0.340	0.610	1.862
469-749	0.29	0.47	3	0.403	0.098	0.394	1.306
471-714	0.71	0.85	2	0.780	0.098	0.776	1.135
472-680	4.32	8.86	3	5.983	2.501	5.672	1.475
476-724	0.67	0.93	3	0.786	0.132	0.779	1.179
477-758	0.42	0.83	3	0.610	0.206	0.586	1.405
479-704	0.93	0.99	3	0.956	0.030	0.956	1.032
482-699	0.55	0.82	3	0.680	0.135	0.671	1.221
488-672	0.35	5.11	3	2.050	2.655	1.072	4.030
490-646	0.29	1.03	3	0.586	0.391	0.508	1.907
490-713	1.02	1.44	3	1.233	0.210	1.221	1.188
490-730	1.06	1.63	3	1.420	0.313	1.394	1.269
495-693	0.51	1.28	3	0.820	0.406	0.759	1.604
495-809	0.53	1.10	3	0.723	0.326	0.680	1.516
498-704	3.43	4.98	3	4.096	0.797	4.046	1.209
499-724	0.76	2.15	3	1.326	0.729	1.204	1.698
501-713	1.09	1.18	3	1.136	0.045	1.136	1.040
505-741	1.32	2.75	3	1.856	0.778	1.759	1.480
509-710	1.01	1.18	3	1.113	0.090	1.110	1.086
517-692	0.99	2.92	3	1.653	1.097	1.447	1.837
517-762	0.49	0.49	2	0.490	0.000	0.490	1.000
520-790	0.55	1.02	3	0.810	0.238	0.784	1.375
521-725	0.87	1.35	3	1.103	0.240	1.085	1.245
554-668	0.21	1.26	3	0.570	0.597	0.398	2.713
585-683	0.21	0.40	3	0.300	0.095	0.289	1.380
All	0.13	8.86	117	0.995	1.241	0.659	2.320

[a] N = number of samples.

decomposition may be the cause. Temperature increases and rainfall decreases during this season of the year also lend support to hypothesized effects of increases in anaerobic decomposition. Meteorological data for downtown St. Louis show averages of 77.9, 79.2, 76.8, and 71.4°F and 2.66, 2.13, 2.39, and 1.47 inches of rainfall, respectively, for the months of June, July, August, and September 1963. Lambert Field data show averages of 75.4, 77.3, 74.9, and 68.5°F, and 3.87, 1.37, 2.55, and 1.13 inches of rainfall, respectively, for the same months.

Table 28. SULFATION FOR SEPTEMBER, OCTOBER, NOVEMBER 1963 (mg SO_3/100 cm^2/day)

Site coordinates	Minimum	Maximum	N[a]	Arithmetic Mean	Arithmetic Standard deviation	Geometric Mean	Geometric Standard deviation
407-770	0.20	0.44	3	0.300	0.124	0.283	1.494
421-729	0.26	0.30	3	0.280	0.019	0.279	1.074
433-565	0.10	0.39	3	0.213	0.155	0.180	2.011
435-589	0.26	0.38	3	0.306	0.064	0.302	1.222
435-717	0.19	0.30	3	0.250	0.055	0.245	1.263
436-743	0.42	0.61	3	0.526	0.097	0.520	1.212
449-719	0.40	0.44	3	0.426	0.023	0.426	1.056
451-728	0.37	0.66	3	0.493	0.149	0.478	1.342
453-701	0.37	0.65	3	0.473	0.153	0.458	1.357
457-766	0.43	0.83	3	0.643	0.201	0.620	1.398
463-691	0.69	0.78	3	0.726	0.047	0.725	1.066
464-740	0.62	1.10	3	0.846	0.241	0.823	1.332
465-731	0.66	1.58	3	1.023	0.489	0.953	1.572
467-758	0.45	0.92	3	0.663	0.237	0.635	1.430
469-683	0.56	0.95	3	0.743	0.196	0.726	1.302
469-705	0.85	1.14	3	0.956	0.159	0.948	1.173
469-749	0.47	0.91	3	0.670	0.222	0.645	1.392
471-714	0.84	1.15	3	0.973	0.159	0.964	1.173
472-680	4.33	7.04	3	5.970	1.442	5.841	1.299
476-724	0.99	1.70	3	1.273	0.376	1.238	1.325
477-758	0.68	1.40	3	0.996	0.367	0.953	1.438
479-704	0.97	1.36	3	1.140	0.199	1.128	1.187
482-699	0.58	0.86	3	0.733	0.141	0.723	1.223
488-672	0.30	2.14	3	1.073	0.954	0.794	2.671
490-646	0.14	1.14	3	0.760	0.541	0.542	3.237
490-713	1.43	1.89	3	1.633	0.234	1.622	1.151
490-730	1.46	1.64	3	1.566	0.094	1.564	1.063
495-693	0.79	1.92	3	1.220	0.611	1.129	1.597
495-809	0.47	2.66	3	1.660	1.107	1.322	2.494
498-704	2.52	3.33	3	3.043	0.260	3.036	1.088
499-724	0.71	3.22	3	1.923	1.257	1.614	2.147
501-713	0.97	2.64	3	1.580	0.921	1.425	1.715
505-741	1.47	2.07	2	1.770	0.424	1.744	1.273
509-710	0.90	2.53	3	1.553	0.861	1.409	1.699
517-692	0.94	2.88	3	1.730	1.018	1.547	1.767
517-762	0.41	1.74	3	0.926	0.712	0.765	2.100
520-790	0.70	1.60	3	1.076	0.467	1.013	1.521
521-725	0.21	1.74	3	0.900	0.775	0.649	2.899
554-668	0.27	1.56	3	1.086	0.710	0.844	2.687
585-683	0.28	0.98	3	0.723	0.385	0.629	2.019
All	0.10	7.04	121	1.127	1.068	0.821	2.214

[a] N = number of samples.

The minimum monthly geometric mean for all stations was 0.517 mg SO_3/100 cm^2/day in June and the maximum was 1.405 mg SO_3/100 cm^2/day in December. The winter season geometric mean was the highest at 1.332 mg SO_3/100 cm^2/day, and the summer geometric mean was the lowest at 0.659 mg SO_3/100 cm^2/day. Figures 88 and 89 are isopleth maps of the annual sulfation geometric means and 99th percentile values.

Table 29. SULFATION FOR DECEMBER 1963, JANUARY AND FEBRUARY 1964

(mg SO_3/100 cm^2/day)

Site coordinates	Minimum	Maximum	N[a]	Arithmetic		Geometric	
				Mean	Standard deviation	Mean	Standard deviation
407-770	0.65	0.73	3	0.680	0.043	0.679	1.065
421-729	0.46	0.52	3	0.483	0.032	0.482	1.067
433-565	0.28	0.59	3	0.383	0.178	0.358	1.537
435-589	0.29	0.51	3	0.376	0.117	0.365	1.344
435-717	0.43	0.63	3	0.540	0.101	0.533	1.216
436-743	0.42	0.92	3	0.710	0.259	0.673	1.515
449-719	0.80	0.93	3	0.863	0.065	0.861	1.078
451-728	0.73	1.01	3	0.866	0.140	0.859	1.176
453-701	0.70	1.01	3	0.820	0.166	0.809	1.215
457-766	0.13	0.86	3	0.576	0.391	0.435	2.858
463-691	0.84	1.14	3	1.006	0.152	0.998	1.169
464-740	0.89	1.70	3	1.190	0.443	1.140	1.417
465-731	1.47	2.47	3	1.876	0.525	1.830	1.303
467-758	0.80	1.46	3	1.050	0.357	1.013	1.378
469-683	1.01	1.27	3	1.150	0.131	1.144	1.123
469-705	1.19	1.83	3	1.553	0.328	1.528	1.250
469-749	0.91	1.50	3	1.136	0.317	1.109	1.304
471-714	1.42	1.93	3	1.663	0.255	1.650	1.165
472-680	3.20	4.85	3	3.950	0.835	3.892	1.232
476-724	1.86	2.64	3	2.200	0.399	2.176	1.194
477-758	0.98	2.11	3	1.413	0.609	1.334	1.498
479-704	1.70	1.91	3	1.800	0.105	1.797	1.060
482-699	0.95	1.77	3	1.280	0.432	1.234	1.380
488-672	0.95	2.04	3	1.403	0.567	1.332	1.476
490-646	0.79	1.86	3	1.270	0.543	1.194	1.535
490-713	1.64	2.59	3	2.186	0.490	2.147	1.270
490-730	1.66	2.06	3	1.796	0.228	1.787	1.130
495-693	1.01	1.51	3	1.290	0.255	1.272	1.230
495-709	2.26	2.61	3	2.423	0.176	2.419	1.074
495-809	1.57	2.29	3	1.880	0.370	1.856	1.211
498-704	2.48	4.59	3	3.670	1.080	3.552	1.377
499-724	3.18	3.93	3	3.620	0.391	3.605	1.117
501-713	3.43	4.17	3	3.910	0.416	3.894	1.116
505-740	3.03	3.03	1				
505-741	3.73	3.77	2	3.750	0.028	3.749	1.007
509-710	2.61	3.56	3	2.966	0.517	2.938	1.182
517-692	2.89	3.15	2	3.020	0.183	3.017	1.062
517-762	1.24	1.54	3	1.356	0.160	1.350	1.122
520-790	1.24	1.78	3	1.570	0.289	1.550	1.215
521-725	1.39	2.19	3	1.826	0.405	1.795	1.261
554-668	1.10	2.35	3	1.593	0.665	1.509	1.484
585-683	0.57	1.06	3	0.846	0.251	0.819	1.381
All	0.13	4.85	122	1.640	1.044	1.332	1.970

[a] N = number of samples.

From the 1960 census population density and the isopleth map of the annual geometric means, it was estimated that 150,000 people lived in areas with a level of 1.5-2.0 mg SO_3/100 cm^2/day and approximately 80,000 people lived in areas with levels of 2.0 mg SO_3/100 cm^2/day or greater. A study by Thomas and Davidson[16] showed that clean air (60 to 70 miles from any source of sulfur dioxide)had a

Table 30. SULFATION FROM MARCH 1963 THROUGH FEBRUARY 1964 (mg SO_3/100 cm^2/day)

Site coordinates	Minimum	Maximum	N[a]	Arithmetic		Geometric	
				Mean	Standard deviation	Mean	Standard deviation
407-770	0.15	0.73	12	0.383	0.208	0.333	1.747
421-729	0.16	0.52	12	0.338	0.119	0.317	1.467
433-565	0.10	0.59	12	0.247	0.134	0.220	1.634
435-589	0.19	0.51	12	0.336	0.082	0.327	1.287
435-717	0.13	0.63	12	0.329	0.150	0.299	1.575
436-743	0.31	0.92	12	0.544	0.199	0.513	1.422
449-719	0.33	0.93	10	0.556	0.218	0.522	1.438
451-728	0.30	1.01	12	0.602	0.240	0.559	1.501
453-701	0.19	1.01	12	0.550	0.258	0.494	1.642
457-766	0.13	0.86	11	0.555	0.246	0.490	1.784
463-691	0.47	1.14	12	0.795	0.195	0.773	1.284
464-740	0.44	4.10	12	1.159	0.984	0.953	1.790
465-731	0.49	3.42	12	1.343	0.881	1.125	1.840
467-758	0.32	1.46	12	0.715	0.320	0.656	1.538
469-683	0.56	1.27	12	0.930	0.249	0.898	1.323
469-705	0.30	1.83	12	1.068	0.415	0.981	1.591
469-749	0.29	1.50	12	0.740	0.350	0.667	1.611
471-714	0.71	1.93	11	1.189	0.410	1.127	1.403
472-680	3.20	8.86	11	5.500	1.725	5.264	1.362
476-724	0.67	2.64	12	1.389	0.619	1.269	1.556
477-758	0.42	2.11	12	0.962	0.458	0.876	1.566
479-704	0.93	1.91	12	1.282	0.360	1.239	1.309
482-699	0.55	1.77	12	0.881	0.326	0.838	1.373
488-672	0.30	5.11	12	1.269	1.354	0.882	2.309
490-646	0.14	1.86	12	0.750	0.503	0.594	2.124
490-713	1.02	2.59	10	1.654	0.487	1.594	1.325
490-730	1.04	2.06	12	1.544	0.282	1.518	1.217
495-693	0.51	1.92	12	1.010	0.422	0.937	1.488
495-709	0.80	2.61	4	2.017	0.824	1.834	1.744
495-809	0.47	2.66	12	1.319	0.722	1.133	1.810
498-704	2.48	4.98	12	3.819	0.834	3.732	1.255
499-724	0.71	3.93	12	2.233	1.144	1.926	1.824
501-713	0.97	4.17	10	2.119	1.337	1.784	1.831
505-740	2.77	3.03	2	2.900	0.183	2.897	1.065
505-741	0.48	3.77	10	2.189	1.066	1.904	1.842
509-710	0.90	3.56	12	1.822	0.858	1.652	1.581
517-692	0.94	3.15	11	1.983	0.951	1.770	1.661
517-762	0.41	1.98	11	1.008	0.568	0.867	1.785
520-790	0.55	1.78	12	1.194	0.418	1.122	1.459
521-725	0.21	2.19	12	1.344	0.559	1.178	1.877
554-668	0.21	2.35	12	0.940	0.680	0.689	2.417
585-683	0.21	1.06	12	0.580	0.309	0.503	1.758
All	0.10	8.86	477	1.228	1.137	0.886	2.245

[a] N = number of samples.

sulfation rate of 0.03 mg SO_3/100 cm^2/day. This means that these 230,000 people lived in areas that had sulfation rates of at least 50 times as high as areas with clean air.

The frequency distribution of the sulfation rates for all sites, shown in Figure 90, reveals that sulfation rates of 3.2 mg SO_3/100 cm^2/day or higher occurred 10 percent of the time during the winter and 2.6 mg SO_3/100 cm^2/day 10 percent of

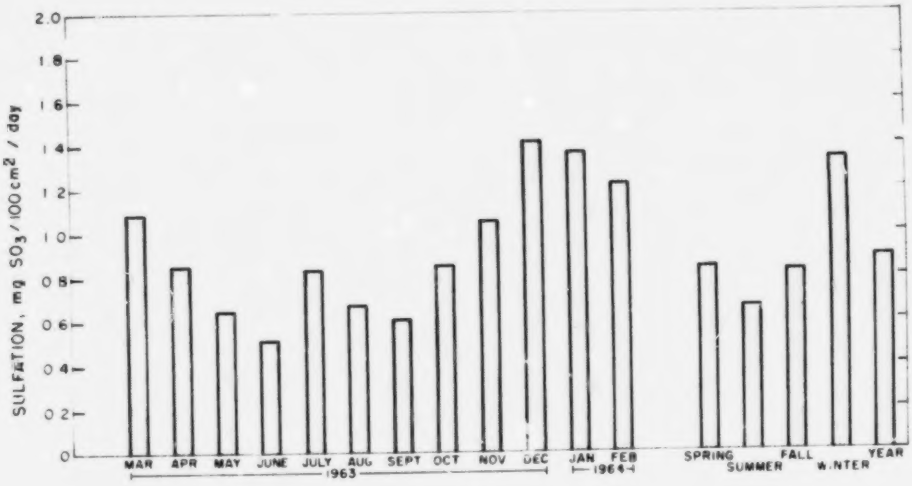


Figure 86. Sulfation - geometric means for months, seasons, and years.

the time during the year. Table 31 presents data from St. Louis and four other cities. St. Louis and Nashville results are total urban area averages for a year. London data are for seven central city stations; the yearly means are averaged arithmetically. The Pennsylvania data are for less than a year, and the Seward station was influenced by a nearby coal-burning power plant and down-valley winds. St. Louis metropolitan area sulfation levels are almost five times those of Nashville, the only truly comparable city on an area-wide basis. The yearly station geometric means of 1.59 at site 490-713 and 1.78 at site 501-713 may be compared to the London value. St. Louis, therefore, has about one-half the sulfation level of London and almost five times that of Nashville.

For the investigation of the statistical relationship between sulfation rates and sulfur dioxide levels the data used were primarily from the 1964-1965 winter network of ten paired sampling stations. The 1963-1964 network station data were found unsuitable for this purpose because the sampling station pairs were not located at the same places and the data, although showing an apparent relationship at paired stations, were insufficient to show a relationship between different pairs of stations. Figure 91 and Table 32 show the data and results for the ten paired stations. The correlation coefficients (0.67-0.72) between the sulfation rates and sulfur dioxide levels are all reasonably good and consistent. Plotted data for individual paired stations also show a consistency in their fluctuations about the means. It is linear and consistent in slope, site by site, between the 1963-64 and 1964-65 winter seasons. The equivalent sulfur dioxide concentration for 1.0 mg SO_3/100 cm^2/day of sulfation using the sulfation versus 24-hour sulfur dioxide geometric

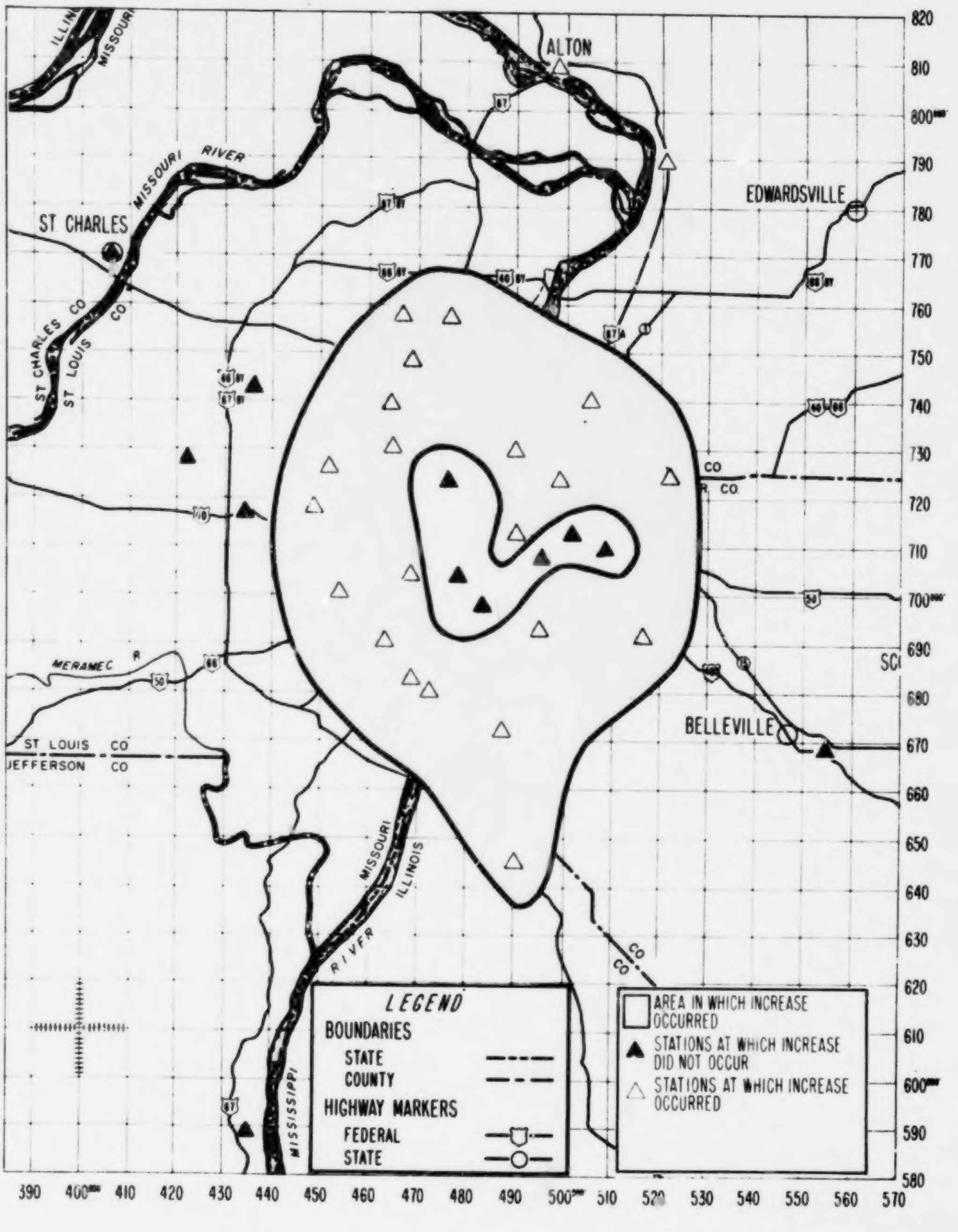
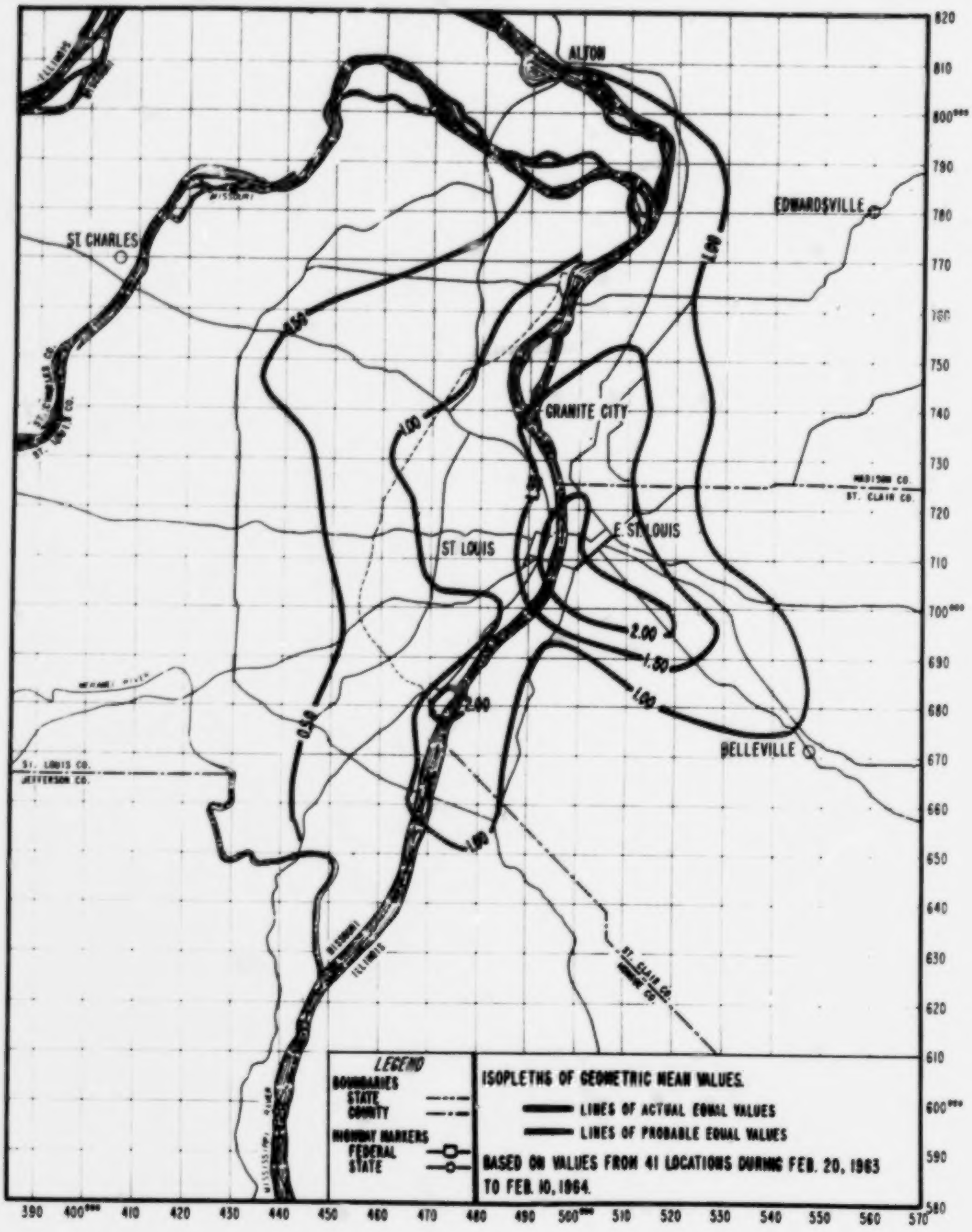

ALTON
EDWARDSVILLE
ST CHARLES
BELLEVILLE
MISSOURI RIVER
MERAMEC R
ILLINOIS
MISSOURI
MISSISSIPPI
RIVER
ST CHARLES CO
ST LOUIS CO
ST LOUIS CO
JEFFERSON CO
LEGEND
BOUNDARIES
STATE
COUNTY
HIGHWAY MARKERS
FEDERAL
STATE
AREA IN WHICH INCREASE OCCURRED
▲ STATIONS AT WHICH INCREASE DID NOT OCCUR
△ STATIONS AT WHICH INCREASE OCCURRED
820
810
800
790
780
770
760
750
740
730
720
710
700
690
680
670
660
650
640
630
620
610
600
590
580
390
400
410
420
430
440
450
460
470
480
490
500
510
520
530
540
550
560
570

Figure 87. Geographic distribution of sulfation increases from June to July 1963.


ALTON
EDWARDSVILLE
ST CHARLES
GRANITE CITY
ST LOUIS
E. ST. LOUIS
BELLEVILLE
MISSOURI
ILLINOIS
MERAMEC RIVER
MISSISSIPPI RIVER
ST. LOUIS CO.
JEFFERSON CO.
MADISON CO.
ST. CLAIR CO.
MONROE CO.
0.50
1.00
1.50
2.00
LEGEND
BOUNDARIES
STATE
COUNTY
HIGHWAY MARKERS
FEDERAL
STATE
ISOPLETHS OF GEOMETRIC MEAN VALUES.
LINES OF ACTUAL EQUAL VALUES
LINES OF PROBABLE EQUAL VALUES
BASED ON VALUES FROM 41 LOCATIONS DURING FEB. 20, 1963 TO FEB. 10, 1964.
820
810
800
790
780
770
760
750
740
730
720
710
700
690
680
670
660
650
640
630
620
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600
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580
390
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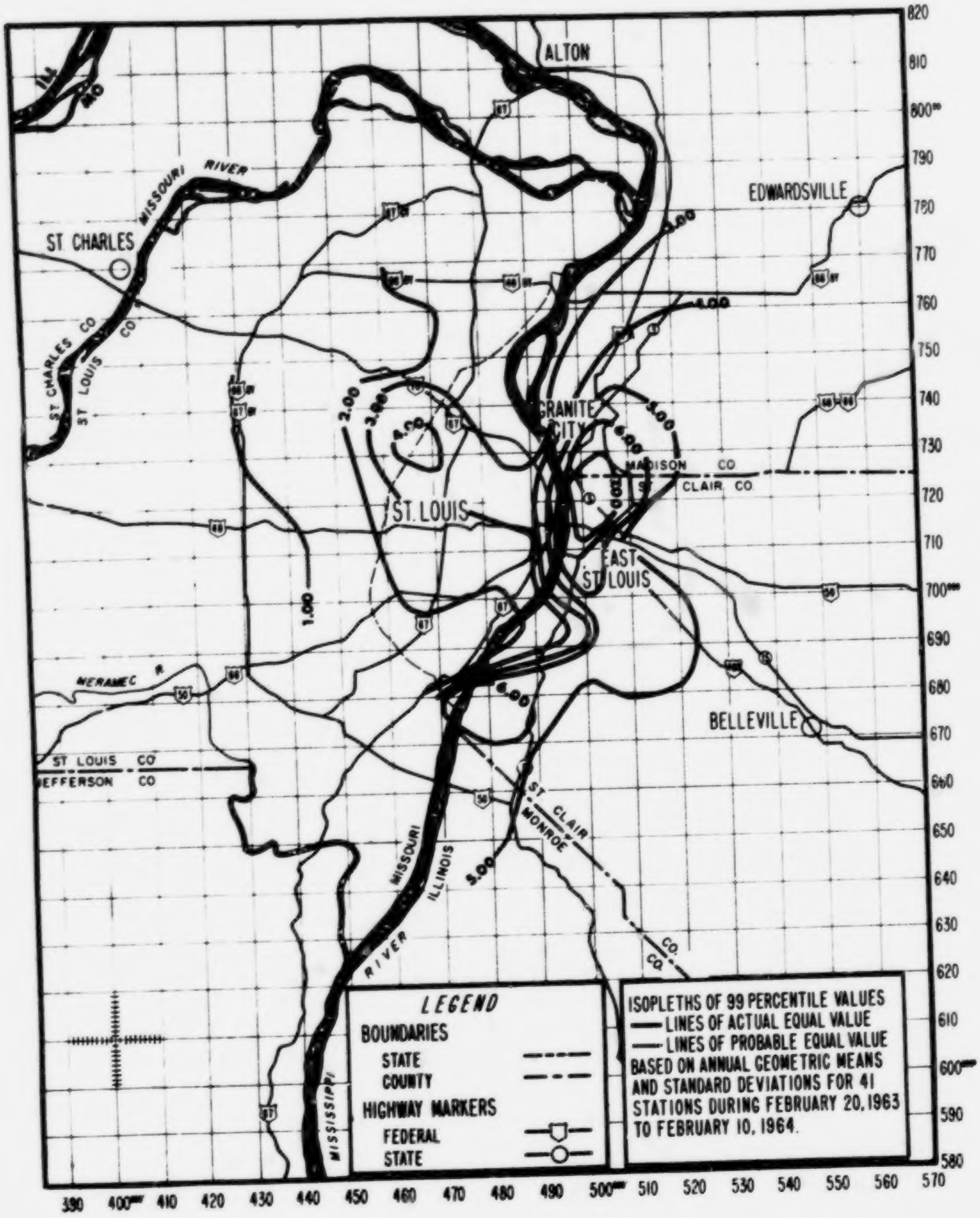
550
560
570

Figure 88. Sulfation - geometric means measured by lead peroxide candles (mg SO_3/100 cm^2/day).


ALTON
EDWARDSVILLE
ST. CHARLES
MISSOURI RIVER
ILL
MO
ST CHARLES CO
ST LOUIS CO
GRANITE CITY
MADISON CO
ST CLAIR CO
ST. LOUIS
EAST ST LOUIS
BELLEVILLE
MERAMEC R
ST LOUIS CO
JEFFERSON CO
ST CLAIR CO
MONROE CO
MISSOURI
ILLINOIS
RIVER
MISSISSIPPI
1.00
2.00
3.00
4.00
5.00
6.00
LEGEND
BOUNDARIES
STATE
COUNTY
HIGHWAY MARKERS
FEDERAL
STATE
ISOPLETHS OF 99 PERCENTILE VALUES
LINES OF ACTUAL EQUAL VALUE
LINES OF PROBABLE EQUAL VALUE
BASED ON ANNUAL GEOMETRIC MEANS AND STANDARD DEVIATIONS FOR 41 STATIONS DURING FEBRUARY 20, 1963 TO FEBRUARY 10, 1964.
820
810
800
790
780
770
760
750
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730
720
710
700
690
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670
660
650
640
630
620
610
600
590
580
390
400
410
420
430
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520
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550
560
570

Figure 89. Sulfation - 99 percentile values measured by lead peroxide candles (mg SO_3/100 cm^2/day).

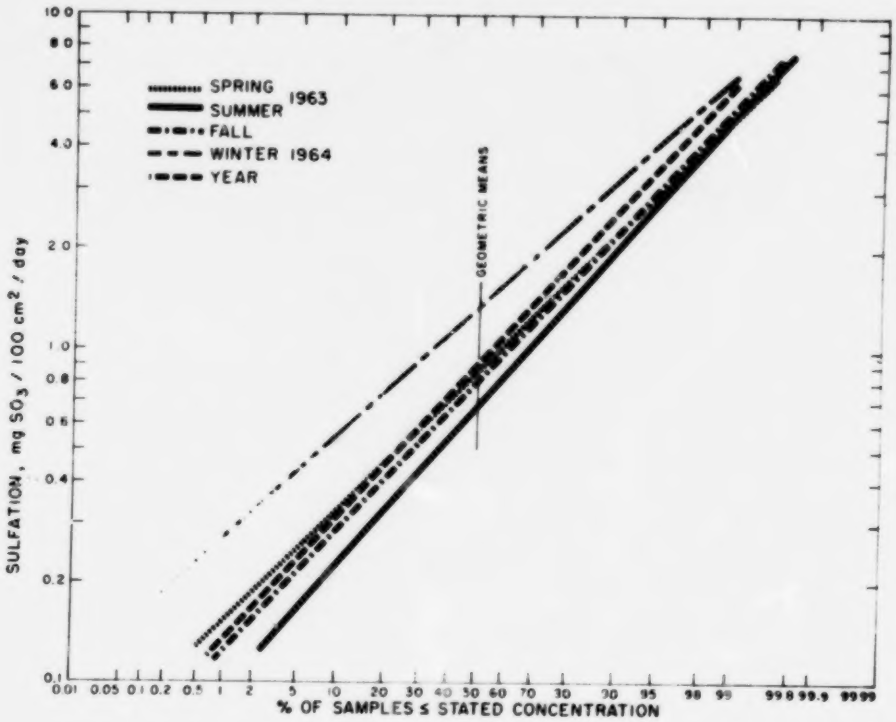


Figure 90. Sulfation frequency distribution, all sites.

Table 31. SULFATION RESULTS FROM ST. LOUIS AND OTHER CITIES

City	Ref	Date	Sulfation rates, mg SO_3/100 cm^2/day	Remarks
Seward, Pa.	60	9/26/59 3/15/60	3.7	Near a coal-burning power plant; down valley winds.
New Florence, Pa.	60	9/26/59 3/15/60	0.6	
London, England	61	1949-54	3.3	7 central city stations.
Nashville	2	1958-59	0.190	Geometric mean.
St. Louis		1963-64	0.886	Geometric mean.
St. Louis (Site 501-713)		1963-64	1.78	Geometric mean.

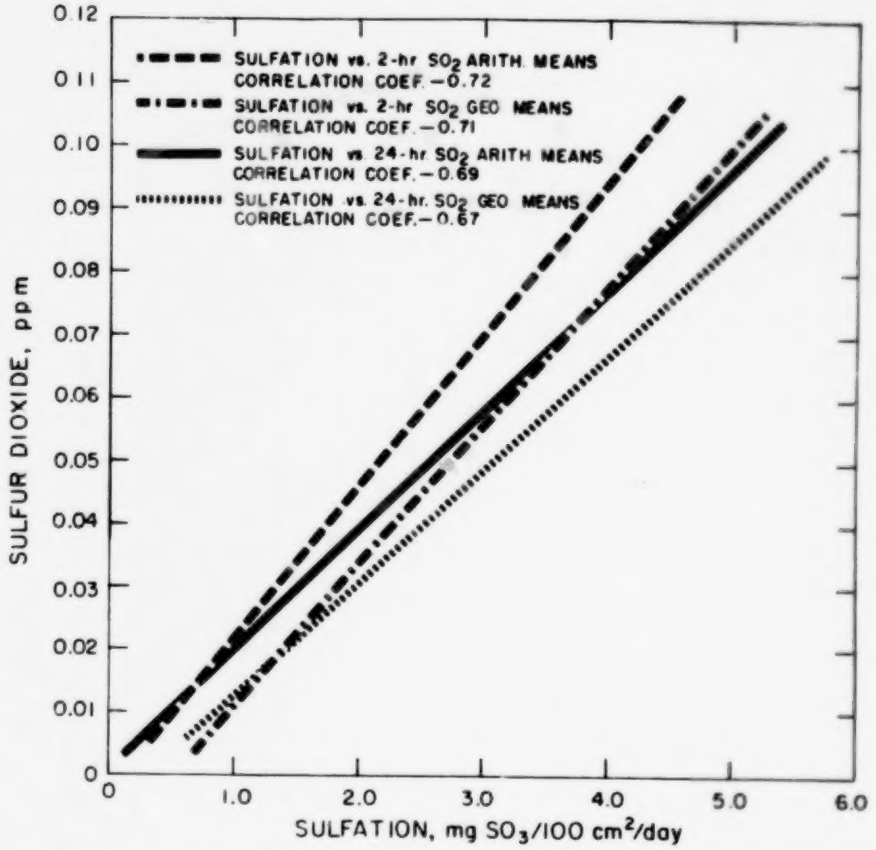


Figure 91. Sulfation versus sulfur dioxide (Dec 1964 - Feb 1965) at 10 paired stations.

means was 0.013 ppm, as compared to 0.042 ppm sulfur dioxide per 1.0 mg $SO_3/100\ cm^2/$ day found in Nashville.[17] These data indicate that compounds other than sulfur dioxide have a greater influence on the sulfation rates in St. Louis than in Nashville.

SULFUR DIOXIDE (West-Gaeke)

Three separate networks of sulfur dioxide samplers were operated during this Study. One network consisting of three sites was equipped with 2-hour sequential samplers. It was operated from May 1963 to July 1964. Results from it are not reported. A second network of twenty 24-hour samplers was operated from December 1963 to February 1964, and another network consisting of forty 24-hour samplers plus ten 2-hour sequential samplers was operated from December 1964 to February 1965. Results of the 20-site network operated in the winter of 1963-64 are given in Table 33 and the results of the 40-site network are listed in Tables 34 and 35.

The ranges of results were 0.00-0.24 ppm for the network of twenty 24-hour samplers (December 1963 - February 1964), 0.00-0.26 ppm for the network of forty

Table 32. DATA FROM 1964-65 SULFUR DIOXIDE STUDY

Site coordinates	Month	SO$_2$ mean, ppm				Sulfation, mg SO$_3$/100 cm^2/day
		2-hr		24-hr		
		Arithmetic	Geometric	Arithmetic	Geometric	
449-719	Dec	0.032	0.020	0.022	0.017	1.70
	Jan	0.023	0.011	0.020	0.014	1.57
	Feb	0.026	0.013	0.021	0.014	1.55
468-724	Dec	0.083	0.072	0.075	0.072	2.02
	Jan	0.079	0.064	0.065	0.059	2.55
	Feb	0.078	0.068	0.068	0.063	2.23
479-738	Dec	0.058	0.040	0.054	0.042	1.21
	Jan	0.050	0.029	0.048	0.037	2.62
	Feb	0.046	0.029	0.041	0.034	1.68
481-736	Dec	0.033	0.021	0.028	0.020	2.47
	Jan	0.034	0.020	0.027	0.021	1.98
	Feb	0.035	0.021	0.028	0.023	1.58
490-713	Dec	0.071	0.049	0.049	0.045	2.27
	Jan	0.048	0.035	0.049	0.043	3.00
	Feb	0.058	0.043	0.049	0.045	2.26
498-729	Dec	0.066	0.049	0.054	0.048	2.83
	Jan	0.065	0.044	0.059	0.050	2.69
	Feb	0.068	0.047	0.057	0.047	2.37
499-706	Dec	0.134	0.108	0.102	0.090	5.54
	Jan	0.131	0.106	0.110	0.102	4.24
	Feb	0.118	0.094	0.103	0.097	3.61
509-710	Dec	0.065	0.053	0.045	0.037	3.50
	Jan	0.065	0.049	0.052	0.045	2.99
	Feb	0.075	0.056	0.059	0.047	2.40
509-751	Dec	0.035	0.020	0.028	0.019	2.59
	Jan	0.034	0.018	0.029	0.022	2.92
	Feb	0.029	0.013	0.021	0.014	1.38
527-702	Dec	0.025	0.017	0.028	0.021	2.66
	Jan	0.031	0.018	0.029	0.022	2.48
	Feb	0.034	0.020	0.030	0.021	1.43

24-hour samplers (December 1964 - February 1965), and 0.00-0.86 ppm for the network of ten 2-hour sequential samplers (December 1964 - February 1965).

The locations of 19 of the 24-hour sampler stations were the same for the winters of 1963-64 and 1964-65. Comparison of the results from these stations (Table 36) shows that the sulfur dioxide concentrations were significantly higher for the winter of 1964-65 than for the winter of 1963-64. The possible reasons for this are: (1) sulfur dioxide concentrations for St. Louis are beginning an upward trend; (2) the meteorological conditions were more conducive to high air pollution during the 1964-65 season than during 1963-64; (3) the 1963-64 samples faded as a

Table 33. 1963-64 SULFUR DIOXIDE 24-HOUR SAMPLES
(ppm)

Site coordinates	Minimum	Maximum	N[a]	Arithmetic		Geometric	
				Mean	Standard deviation	Mean	Standard deviation
Dec 1963							
466-742	0.002	0.04	20	0.017	0.015	0.010	3.011
471-689	0.004	0.07	22	0.026	0.022	0.018	2.523
472-707	0.000	0.11	22	0.027	0.032	0.011	4.799
480-682	0.000	0.09	13	0.024	0.027	0.012	4.076
481-696	0.000	0.13	20	0.034	0.039	0.012	5.318
481-726	0.008	0.17	20	0.054	0.042	0.040	2.337
487-706	0.015	0.15	19	0.065	0.038	0.054	1.897
490-759	0.000	0.04	20	0.015	0.015	0.006	4.559
491-692	0.000	0.07	21	0.022	0.025	0.008	5.082
494-721	0.004	0.10	18	0.039	0.027	0.028	2.522
498-718	0.021	0.07	12	0.040	0.018	0.036	1.562
498-729	0.001	0.14	19	0.043	0.041	0.019	5.207
499-743	0.002	0.06	21	0.021	0.018	0.014	2.699
502-736	0.002	0.08	18	0.029	0.025	0.019	2.847
503-723	0.003	0.07	17	0.033	0.021	0.025	2.275
509-751	0.000	0.06	20	0.019	0.019	0.008	4.532
513-742	0.000	0.03	19	0.013	0.010	0.007	3.408
515-690	0.001	0.09	17	0.028	0.026	0.016	3.632
518-716	0.010	0.09	21	0.034	0.022	0.028	1.853
533-717	0.002	0.03	20	0.013	0.008	0.010	2.157
All	0.000	0.17	379	0.029	0.029	0.016	3.678
Jan 1964							
466-742	0.003	0.20	27	0.037	0.043	0.020	3.321
471-689	0.005	0.13	27	0.034	0.035	0.022	2.470
472-707	0.002	0.06	27	0.023	0.019	0.016	2.643
480-682	0.003	0.04	26	0.015	0.011	0.012	2.145
481-696	0.003	0.05	27	0.021	0.015	0.016	2.145
481-726	0.011	0.17	27	0.069	0.050	0.050	2.350
487-706	0.008	0.14	27	0.056	0.037	0.044	2.153
490-759	0.001	0.08	27	0.029	0.026	0.016	3.613
491-692	0.000	0.04	28	0.006	0.009	0.003	3.022
494-721	0.007	0.12	24	0.057	0.037	0.043	2.321
498-718	0.002	0.24	27	0.045	0.047	0.030	2.519
498-729	0.003	0.14	26	0.055	0.043	0.038	2.588
499-743	0.002	0.08	26	0.024	0.020	0.015	3.069
502-736	0.002	0.09	27	0.032	0.027	0.021	2.791
503-723	0.016	0.14	26	0.044	0.026	0.038	1.618
509-751	0.000	0.08	26	0.027	0.027	0.014	3.726
513-742	0.000	0.05	25	0.010	0.011	0.006	2.955
515-690	0.007	0.08	23	0.031	0.021	0.024	2.145
518-716	0.008	0.08	27	0.032	0.021	0.026	1.993
533-717	0.005	0.06	27	0.019	0.015	0.014	2.033
All	0.000	0.24	527	0.033	0.033	0.020	3.119

[a] N = number of samples.

Table 33. (Cont'd) 1963-64 SULFUR DIOXIDE 24-HOUR SAMPLES (ppm)

Site coordinates	Minimum	Maximum	N[a]	Arithmetic Mean	Arithmetic Standard deviation	Geometric Mean	Geometric Standard deviation
Feb 1964							
466-742	0.001	0.07	25	0.022	0.021	0.013	3.322
471-689	0.002	0.05	26	0.019	0.016	0.014	2.490
472-707	0.001	0.04	24	0.011	0.013	0.007	2.819
480-682	0.001	0.04	27	0.015	0.010	0.012	2.380
481-696	0.003	0.09	27	0.025	0.020	0.019	2.161
481-726	0.009	0.10	25	0.045	0.027	0.036	2.053
487-706	0.003	0.08	27	0.037	0.017	0.032	1.917
490-759	0.001	0.03	27	0.010	0.009	0.007	2.790
491-692	0.001	0.03	27	0.008	0.006	0.006	2.137
494-721	0.008	0.16	25	0.034	0.031	0.026	2.039
498-718	0.004	0.12	27	0.024	0.023	0.017	2.180
498-729	0.007	0.10	25	0.037	0.027	0.027	2.257
499-743	0.002	0.04	27	0.010	0.008	0.008	1.918
502-736	0.008	0.06	27	0.032	0.017	0.027	1.833
503-723	0.002	0.05	27	0.029	0.015	0.023	2.286
509-751	0.001	0.04	25	0.012	0.014	0.006	3.303
513-742	0.000	0.03	27	0.010	0.007	0.007	2.574
515-690	0.009	0.05	26	0.028	0.012	0.026	1.620
518-716	0.003	0.06	25	0.027	0.017	0.021	2.239
533-717	0.001	0.02	27	0.012	0.006	0.009	2.283
All	0.000	0.16	523	0.022	0.020	0.014	2.751
Winter							
466-742	0.001	0.20	72	0.026	0.031	0.014	3.298
471-689	0.002	0.13	75	0.027	0.026	0.018	2.518
472-707	0.000	0.11	73	0.021	0.023	0.011	3.441
480-682	0.000	0.09	66	0.017	0.015	0.012	2.568
481-696	0.000	0.13	74	0.026	0.026	0.016	2.957
481-726	0.008	0.17	72	0.056	0.042	0.042	2.249
487-706	0.003	0.15	73	0.051	0.033	0.041	2.042
490-759	0.000	0.08	74	0.019	0.020	0.009	3.737
491-692	0.000	0.07	76	0.011	0.016	0.005	3.385
494-721	0.004	0.16	67	0.043	0.033	0.032	2.313
498-718	0.002	0.24	66	0.035	0.035	0.025	2.324
498-729	0.001	0.14	70	0.045	0.038	0.028	3.191
499-743	0.002	0.08	74	0.018	0.017	0.012	2.632
502-736	0.002	0.09	72	0.031	0.023	0.022	2.451
503-723	0.002	0.14	70	0.035	0.022	0.028	2.102
509-751	0.000	0.08	71	0.020	0.022	0.009	3.855
513-742	0.000	0.05	71	0.011	0.010	0.006	2.897
515-690	0.001	0.09	66	0.029	0.020	0.022	2.358
518-716	0.003	0.09	73	0.031	0.020	0.025	2.038
533-717	0.001	0.06	74	0.015	0.011	0.011	2.182
All	0.000	0.24	1429	0.028	0.028	0.016	3.150

[a] N = number of samples.

Table 34. 1964-65 SULFUR DIOXIDE 24-HOUR SAMPLES (ppm)

Site coordinates	Minimum	Maximum	N[a]	Arithmetic		Geometric	
				Mean	Standard deviation	Mean	Standard deviation
Dec 1964							
449-719	0.004	0.07	30	0.022	0.016	0.017	2.078
450-703	0.008	0.05	26	0.025	0.011	0.023	1.626
453-735	0.003	0.06	24	0.027	0.017	0.021	2.223
466-742	0.006	0.08	22	0.038	0.023	0.030	2.151
467-697	0.008	0.12	28	0.038	0.028	0.029	2.095
468-718	0.002	0.08	16	0.042	0.026	0.031	2.680
468-724	0.034	0.12	31	0.075	0.021	0.072	1.346
471-689	0.010	0.19	26	0.053	0.044	0.040	2.119
472-707	0.011	0.08	26	0.036	0.017	0.032	1.617
474-756	0.008	0.12	29	0.037	0.031	0.028	2.180
478-723	0.012	0.08	31	0.036	0.015	0.033	1.560
479-738	0.004	0.16	27	0.054	0.036	0.042	2.156
480-682	0.006	0.05	25	0.022	0.012	0.019	1.683
480-712	0.027	0.10	29	0.065	0.023	0.060	1.465
481-696	0.004	0.09	29	0.028	0.025	0.020	2.287
486-718	0.026	0.19	28	0.080	0.034	0.073	1.523
487-706	0.023	0.12	30	0.064	0.029	0.058	1.585
488-730	0.013	0.21	29	0.069	0.048	0.055	2.021
490-713	0.018	0.08	29	0.049	0.020	0.045	1.554
490-759	0.007	0.09	23	0.031	0.028	0.022	2.334
491-692	0.004	0.09	30	0.024	0.023	0.015	2.682
494-721	0.014	0.19	31	0.063	0.041	0.053	1.841
498-696	0.002	0.13	19	0.042	0.038	0.026	3.249
498-718	0.014	0.10	31	0.052	0.024	0.046	1.649
498-729	0.020	0.12	25	0.054	0.027	0.048	1.620
499-706	0.030	0.25	21	0.102	0.052	0.090	1.654
499-743	0.000	0.08	31	0.035	0.026	0.021	3.475
501-713	0.005	0.18	31	0.083	0.042	0.069	2.085
502-736	0.016	0.17	29	0.055	0.033	0.048	1.705
503-723	0.011	0.09	29	0.042	0.021	0.036	1.773
509-700	0.003	0.13	28	0.055	0.035	0.043	2.199
509-710	0.013	0.11	29	0.045	0.028	0.037	1.858
509-720	0.017	0.12	24	0.050	0.031	0.042	1.829
509-751	0.003	0.08	29	0.028	0.023	0.019	2.496
513-742	0.002	0.07	29	0.024	0.017	0.018	2.247
515-690	0.025	0.11	29	0.056	0.022	0.052	1.485
518-716	0.010	0.11	30	0.044	0.027	0.036	1.897
521-733	0.005	0.08	29	0.030	0.022	0.023	2.120
527-702	0.005	0.06	24	0.028	0.017	0.021	2.183
533-717	0.004	0.07	29	0.018	0.015	0.014	2.098

[a] N = number of samples.

Table 34. (Cont'd) 1964-65 SULFUR DIOXIDE 24-HOUR SAMPLES (ppm)

Site coordinates	Minimum	Maximum	N[a]	Arithmetic Mean	Arithmetic Standard deviation	Geometric Mean	Geometric Standard deviation
Jan 1965							
449-719	0.002	0.06	29	0.020	0.017	0.014	2.573
450-703	0.002	0.05	30	0.019	0.013	0.014	2.198
453-735	0.002	0.08	29	0.024	0.020	0.016	2.619
466-742	0.003	0.09	28	0.029	0.024	0.021	2.436
467-697	0.006	0.08	30	0.037	0.022	0.029	2.139
468-718	0.008	0.11	29	0.038	0.027	0.029	2.111
468-724	0.023	0.14	31	0.065	0.030	0.059	1.565
471-689	0.011	0.11	30	0.041	0.023	0.035	1.840
472-707	0.005	0.08	30	0.034	0.022	0.027	2.072
474-756	0.003	0.09	31	0.033	0.025	0.023	2.507
478-723	0.009	0.10	31	0.041	0.021	0.036	1.754
479-738	0.005	0.14	31	0.048	0.034	0.037	2.199
480-682	0.006	0.07	30	0.027	0.014	0.023	1.744
480-712	0.020	0.13	29	0.062	0.028	0.056	1.610
481-696	0.005	0.07	31	0.027	0.018	0.021	2.182
486-718	0.023	0.15	27	0.074	0.032	0.066	1.655
487-706	0.013	0.18	29	0.066	0.036	0.056	1.852
488-730	0.014	0.14	30	0.060	0.036	0.049	1.969
490-713	0.012	0.10	28	0.049	0.025	0.043	1.739
490-759	0.002	0.06	30	0.029	0.018	0.021	2.407
491-692	0.001	0.07	30	0.025	0.021	0.015	2.964
494-721	0.016	0.14	29	0.062	0.034	0.053	1.799
498-696	0.003	0.11	29	0.039	0.030	0.027	2.612
498-718	0.011	0.08	31	0.046	0.020	0.041	1.641
498-729	0.013	0.14	29	0.059	0.033	0.050	1.832
499-706	0.041	0.22	31	0.110	0.042	0.102	1.498
499-743	0.005	0.12	30	0.044	0.030	0.033	2.322
501-713	0.036	0.20	27	0.091	0.038	0.084	1.532
502-736	0.006	0.15	31	0.057	0.029	0.049	1.850
503-723	0.014	0.19	28	0.054	0.042	0.043	1.867
509-700	0.006	0.17	25	0.064	0.039	0.052	2.095
509-710	0.008	0.11	31	0.052	0.026	0.045	1.849
509-720	0.011	0.16	28	0.044	0.030	0.038	1.714
509-751	0.004	0.11	27	0.029	0.024	0.022	2.160
513-742	0.012	0.14	31	0.039	0.029	0.032	1.815
515-690	0.008	0.09	30	0.054	0.022	0.048	1.707
518-716	0.009	0.10	29	0.045	0.024	0.037	1.972
521-733	0.004	0.07	30	0.037	0.020	0.030	1.966
527-702	0.005	0.06	31	0.029	0.018	0.022	2.289
533-717	0.002	0.05	29	0.019	0.010	0.016	2.110

[a] N = number of samples.

Table 34. (Cont'd) 1964-65 SULFUR DIOXIDE 24-HOUR SAMPLES
(ppm)

Site coordinates	Minimum	Maximum	N[a]	Arithmetic		Geometric	
				Mean	Standard deviation	Mean	Standard deviation
Feb 1965							
449-719	0.002	0.06	24	0.021	0.017	0.014	2.602
450-703	0.004	0.04	27	0.019	0.012	0.015	2.031
453-735	0.004	0.04	26	0.022	0.011	0.018	1.947
466-742	0.004	0.06	25	0.027	0.020	0.020	2.293
467-697	0.006	0.07	27	0.033	0.022	0.026	2.139
468-718	0.007	0.08	27	0.034	0.021	0.027	1.977
468-724	0.039	0.17	27	0.068	0.028	0.063	1.416
471-689	0.010	0.10	27	0.041	0.025	0.033	1.964
472-707	0.009	0.07	27	0.031	0.018	0.026	1.849
474-756	0.004	0.09	27	0.029	0.024	0.021	2.269
478-723	0.007	0.19	22	0.070	0.053	0.046	2.941
479-738	0.010	0.09	27	0.041	0.025	0.034	1.894
480-682	0.010	0.06	27	0.029	0.012	0.026	1.584
480-712	0.019	0.10	27	0.053	0.020	0.049	1.494
481-696	0.006	0.10	26	0.028	0.021	0.023	1.897
486-718	0.030	0.12	27	0.075	0.026	0.071	1.437
487-706	0.018	0.13	27	0.063	0.026	0.057	1.607
488-730	0.019	0.16	27	0.057	0.033	0.048	1.774
490-713	0.024	0.11	27	0.049	0.022	0.045	1.552
490-759	0.003	0.09	27	0.031	0.028	0.021	2.644
491-692	0.003	0.06	27	0.022	0.016	0.017	2.144
494-721	0.015	0.10	27	0.052	0.027	0.045	1.715
498-696	0.005	0.09	27	0.034	0.024	0.026	2.211
498-718	0.012	0.26	26	0.071	0.058	0.055	2.076
498-729	0.019	0.14	27	0.057	0.037	0.047	1.835
499-706	0.054	0.19	26	0.103	0.037	0.097	1.431
499-743	0.006	0.16	26	0.047	0.043	0.031	2.609
501-713	0.034	0.22	27	0.083	0.046	0.074	1.642
502-736	0.013	0.12	27	0.049	0.029	0.042	1.756
503-723	0.004	0.23	27	0.055	0.050	0.040	2.280
509-700	0.006	0.12	27	0.051	0.033	0.040	2.153
509-710	0.015	0.16	27	0.059	0.038	0.047	1.987
509-720	0.010	0.09	27	0.047	0.022	0.041	1.774
509-751	0.002	0.06	26	0.021	0.017	0.014	2.613
513-742	0.006	0.06	27	0.031	0.016	0.027	1.872
515-690	0.011	0.09	27	0.043	0.018	0.039	1.636
518-716	0.012	0.12	27	0.049	0.031	0.040	2.018
521-733	0.007	0.06	27	0.032	0.015	0.028	1.799
527-702	0.006	0.09	27	0.030	0.025	0.021	2.358
533-717	0.005	0.07	27	0.023	0.019	0.017	2.188

[a] N = number of samples.

Table 34. (Cont'd) 1964-65 SULFUR DIOXIDE 24-HOUR SAMPLES (ppm)

Site coordinates	Minimum	Maximum	N[a]	Arithmetic		Geometric	
				Mean	Standard deviation	Mean	Standard deviation
Dec '64 - Feb '65							
449-719	0.002	0.07	83	0.021	0.016	0.015	2.393
450-703	0.002	0.05	83	0.021	0.013	0.017	2.011
453-735	0.002	0.08	79	0.024	0.017	0.018	2.271
466-742	0.003	0.09	75	0.031	0.023	0.023	2.323
467-697	0.006	0.12	85	0.036	0.024	0.028	2.110
468-718	0.002	0.11	72	0.037	0.024	0.029	2.166
468-724	0.023	0.17	89	0.069	0.026	0.065	1.455
471-689	0.010	0.19	83	0.045	0.032	0.036	1.961
472-707	0.005	0.08	83	0.034	0.019	0.028	1.863
474-756	0.003	0.12	87	0.033	0.027	0.024	2.318
478-723	0.007	0.19	84	0.047	0.034	0.037	2.024
479-738	0.004	0.16	85	0.048	0.032	0.037	2.082
480-682	0.006	0.07	82	0.026	0.013	0.023	1.686
480-712	0.019	0.13	85	0.060	0.024	0.055	1.531
481-696	0.004	0.10	86	0.028	0.021	0.021	2.118
486-718	0.023	0.19	82	0.076	0.031	0.070	1.536
487-706	0.013	0.18	86	0.064	0.030	0.057	1.675
488-730	0.013	0.21	86	0.062	0.040	0.051	1.917
490-713	0.012	0.11	84	0.049	0.022	0.044	1.609
490-759	0.002	0.09	80	0.030	0.024	0.021	2.439
491-692	0.001	0.09	87	0.023	0.020	0.016	2.589
494-721	0.014	0.19	87	0.059	0.035	0.050	1.785
498-696	0.002	0.13	75	0.038	0.030	0.026	2.594
498-718	0.011	0.26	88	0.056	0.037	0.047	1.786
498-729	0.013	0.14	81	0.057	0.032	0.048	1.759
499-706	0.030	0.25	78	0.106	0.043	0.097	1.517
499-743	0.000	0.16	87	0.042	0.033	0.028	2.833
501-713	0.005	0.22	85	0.086	0.042	0.075	1.779
502-736	0.006	0.17	87	0.054	0.030	0.046	1.767
503-723	0.004	0.23	84	0.050	0.039	0.040	1.965
509-700	0.003	0.17	80	0.057	0.035	0.045	2.145
509-710	0.008	0.16	87	0.052	0.031	0.043	1.896
509-720	0.010	0.16	79	0.047	0.028	0.040	1.760
509-751	0.002	0.11	82	0.026	0.021	0.018	2.436
513-742	0.002	0.14	87	0.032	0.022	0.025	2.043
515-690	0.008	0.11	36	0.051	0.021	0.046	1.628
518-716	0.009	0.12	86	0.046	0.027	0.037	1.947
521-733	0.004	0.08	86	0.033	0.019	0.027	1.969
527-702	0.005	0.09	82	0.029	0.020	0.022	2.258
533-717	0.002	0.07	85	0.020	0.015	0.016	2.123
Dec. 1964 ALL	0.000	0.25	1095	.046	0.033	0.034	2.299
Jan. 1965 ALL	0.001	0.22	1179	.045	0.033	0.034	2.322
Feb. 1965 ALL	0.002	0.26	1064	.044	0.034	0.033	2.274
Dec. 1964 - Feb. 1965 ALL	0.000	0.26	3338	.045	0.033	0.034	2.299

[a] N = number of samples.

Table 35. 1964-65 SULFUR DIOXIDE 2-HOUR SEQUENTIAL SAMPLES
(ppm)

Site coordinates	Minimum	Maximum	N[a]	Arithmetic		Geometric	
				Mean	Standard deviation	Mean	Standard deviation
Dec 1964							
449-719	0.000	0.30	356	0.032	0 .034	0.020	2.615
468-724	0.012	0.29	368	0.083	0 .043	0.072	1.718
479-738	0.000	0.28	332	0.058	0 .049	0.040	2.463
481-696	0.000	0.25	336	0.033	0 .040	0.021	2.503
490-713	0.008	0.39	370	0.071	0 .069	0.049	2.307
498-729	0.004	0.28	289	0.066	0 .050	0.049	2.250
499-706	0.007	0.57	312	0.134	0 .091	0.108	1.947
509-710	0.011	0.29	351	0.065	0 .046	0.053	1.884
509-751	0.004	0.31	224	0.035	0 .045	0.020	2.791
527-702	0.003	0.18	297	0.025	0 .025	0.017	2.386
Jan 1965							
449-719	0.000	0.29	334	0.023	0 .034	0.011	3.195
468-724	0.002	0.34	361	0.079	0 .053	0.064	1.938
479-738	0.003	0.38	342	0.050	0 .054	0.029	2.923
481-696	0.001	0.29	342	0.034	0 .040	0.020	2.858
490-713	0.001	0.26	357	0.048	0 .041	0.035	2.293
498-729	0.000	0.55	303	0.065	0 .064	0.044	2.475
499-706	0.009	0.86	361	0.131	0 .094	0.106	1.932
509-710	0.003	0.34	340	0.065	0 .049	0.049	2.257
509-751	0.001	0.38	257	0.034	0 .046	0.018	3.107
527-702	0.000	0.17	365	0.031	0 .029	0.018	3.153
Feb 1965							
449-719	0.000	0.15	249	0.026	0 .030	0.013	3.471
468-724	0.011	0.25	308	0.078	0 .043	0.068	1.712
479-738	0.000	0.28	232	0.046	0 .044	0.029	2.815
481-696	0.001	0.24	290	0.035	0 .041	0.021	2.752
490-713	0.004	0.30	316	0.058	0 .048	0.043	2.200
498-729	0.006	0.37	285	0.068	0 .063	0.047	2.370
499-706	0.000	0.61	308	0.118	0 .084	0.094	2.143
509-710	0.009	0.28	295	0.075	0 .059	0.056	2.162
509-751	0.001	0.26	301	0.029	0 .040	0.013	3.807
527-702	0.000	0.22	296	0.034	0 .033	0.020	2.953
Dec 64 - Feb '65							
449-719	0.000	0 .30	939	0 .027	0 .033	0.015	3.127
468-724	0.002	0 .34	1037	0 .080	0 .047	0.068	1.797
479-738	0.000	0 .38	906	0 .052	0 .050	0.033	2.755
481-696	0.000	0 .29	968	0 .034	0 .040	0.021	2.701
490-713	0.001	0 .39	1043	0 .059	0 .055	0.042	2.297
498-729	0.000	0 .55	877	0 .066	0 .060	0 .046	2.368
499-706	0.000	0 .86	981	0 .128	0 .090	0 .103	2.008
509-710	0.003	0 .34	986	0 .068	0 .051	0 .052	2.101
509-751	0.001	0 .38	782	0 .032	0 .044	0 .016	3.320
527-702	0.000	0 .22	958	0 .030	0 .029	0 .018	2.856
Dec. 1964 All	0.000	0 .57	3235	0 .061	0 .060	0 .039	2.727
Jan. 1965 All	0.000	0 .86	3362	0 .057	0 .062	0 .033	3.159
Feb. 1965 All	0.000	0 .61	2880	0 .058	0 .058	0 .034	3.186
Dec. 1964- Feb. 1965 All	0.000	0 .86	9477	0 .059	0 .060	0 .035	3.026

[a] N = number of samples.

Table 36. COMPARISON OF 1963-64 AND 1964-65 SULFUR DIOXIDE RESULTS

Site coordinates	24-hour SO_2 arithmetic means, ppm		
	Dec 1963 - Feb 1964	Dec 1964 - Feb 1965	Difference (1964-65 - 1963-64)
466-742	0.026	0.031	+0.005
471-689	0.027	0.045	+0.018
472-707	0.021	0.034	+0.013
480-682	0.017	0.026	+0.009
481-696	0.026	0.028	+0.002
487-706	0.051	0.064	+0.013
490-759	0.019	0.030	+0.011
491-692	0.011	0.023	+0.012
494-721	0.043	0.059	+0.016
498-718	0.035	0.056	+0.021
498-729	0.045	0.057	+0.012
499-743	0.018	0.042	+0.024
502-736	0.031	0.054	+0.023
503-723	0.035	0.050	+0.015
509-751	0.020	0.026	+0.006
513-742	0.011	0.032	+0.021
515-690	0.029	0.051	+0.022
518-716	0.031	0.046	+0.015
533-717	0.015	0.020	+0.005

result of being mailed to Cincinnati for analysis, but the 1964-65 samples, analyzed in St. Louis, had little, if any, time to fade; and (4) the 1963-64 samples were prefiltered whereas the 1964-65 samples were not. Examination of 99th percentile values for stations operating at the same location during both winter seasons showed only small differences. This fact increases confidence in the measurement method. The effect of the prefilters was found to be a reduction of 2 to 4 percent in measured sulfur dioxide levels. This determination was made by "t" test for matched pairs. The "matched pairs" of samplers providing the data were bubblers operating in parallel in the same sampler; one with a filter on the inlet and the other without.

Comparison of the matched pairs of arithmetic monthly means from the ten stations that had both 2-hour sequential and 24-hour samplers during the 1964-65 network operation indicates that the monthly 2-hour sequential sampler arithmetic means were 15 to 24 percent greater than the monthly 24-hour sampler arithmetic means. The "t" test for matched pairs was used to calculate the difference at the 95 percent confidence level. The Nashville[18] study showed that the 24-hour sampler results were 25 to 35 percent higher than the 2-hour sequential sampler results. In other words, the relationship between the two sampling periods is reversed in the two studies.

CAMP station sulfur dioxide readings by means of a conductivity method were correlated with the results of the 2-hour and 24-hour samplers located at the CAMP station (490-713) during the 1964-65 study. Correlation coefficients of 0.95 and 0.80 were obtained for the 2-hour sampler results versus CAMP results and 24-hour sampler results versus CAMP results, respectively. By means of least squares, the following straight line equations were determined for the two correlations:

$Y = 0.985\ X - 0.0114$, where Y = CAMP results and X = 2-hour results,

$Y = 0.988\ X - 0.00058$, where Y = CAMP results and X = 24-hour results.

These equations indicate that the 2-hour and 24-hour sampler results, which were determined by the West and Gaeke method, were higher than the CAMP results. Normally the opposite relationship will occur and there is no logical explanation for this at present.

Figures 92 and 93 are isopleth maps of the 24-hour sampler geometric means and 99th percentile values, based on geometric means and standard deviations, for the 1963-64 sulfur dioxide network. From the isopleth map of the geometric means and the 1960 census population density, it was determined that approximately 140,000 people lived in areas with concentrations of 0.04 ppm and greater and that approximately 225,000 people lived in areas with concentrations between 0.03 and 0.04 ppm. Figures 94 and 95 are isopleth maps of the 24-hour sampler geometric means and 99th percentile values from the 1964-65 sulfur dioxide network operation.

The State of California has adopted an ambient air quality standard of 1.0 ppm for 1 hour, or 0.3 ppm for 8 hours.[19] The State of Colorado air quality standard is 0.1 ppm for 24 hours or 0.5 ppm for 1 hour.[8] The State of New York standards, applicable to regional objectives and subregions, range from 0.1 to 0.15 ppm for 24 hours and 0.25 to 0.40 ppm for 1 hour.[7] The U.S.S.R. and Czechoslovakian standard is 0.05 ppm for 24 hours.[20]

Figure 96 gives the frequency distributions for sites 481-726, which had the highest results; 491-692, which had the lowest results; 494-721, an industrial area; and all 20 sites combined for the 1963-64 network of 24-hour samplers. These distributions reveal that the Colorado standard of 0.1 ppm for 24 hours was exceeded 15 percent of the time at site 481-726, and 6 percent of the time for all sites combined. Ten of the 20 sites had one or more results above the Colorado standard, and all sites had results equal to or greater than the Russian standard of 0.05 ppm for 24 hours.

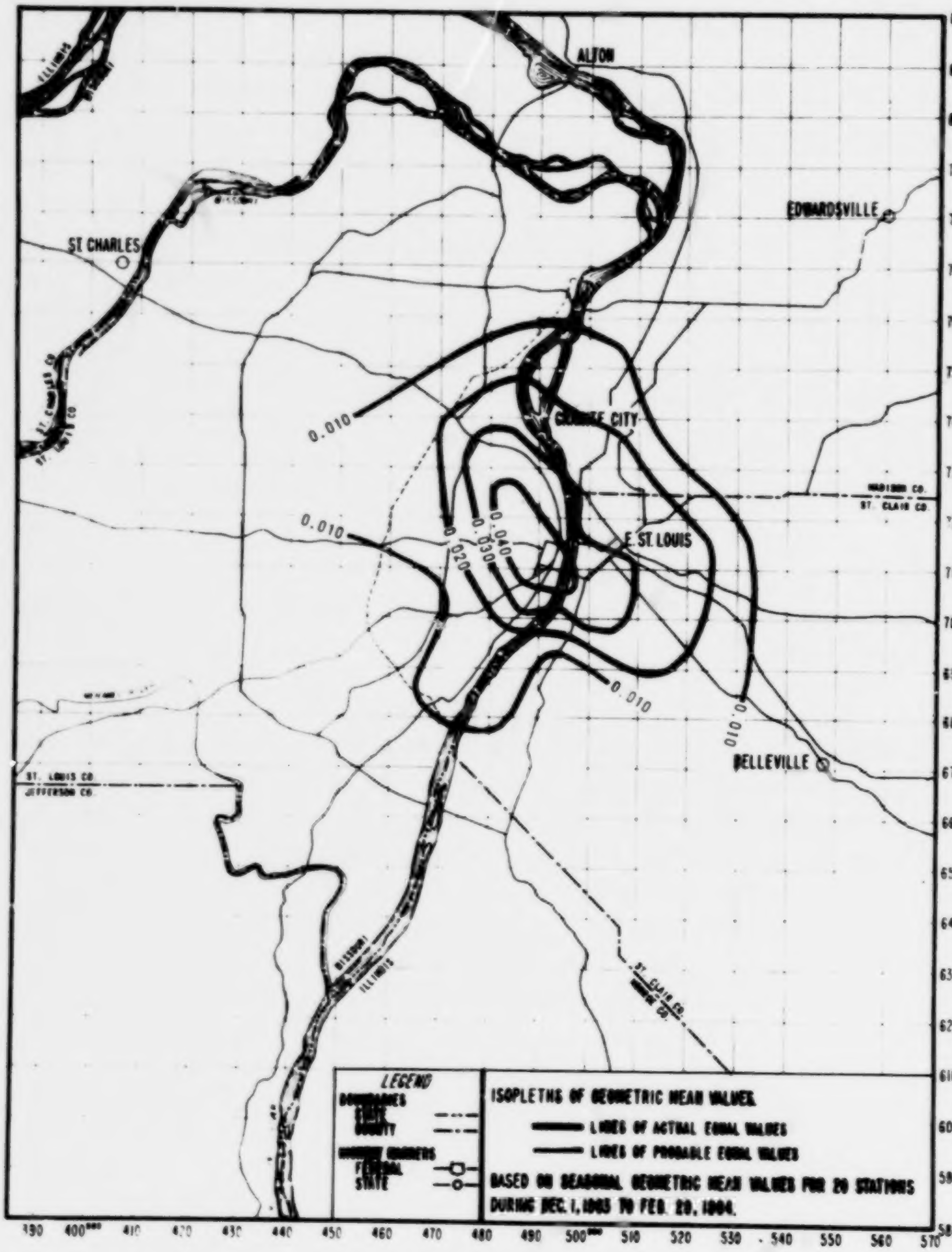

ALTON
EDWARDSVILLE
ST CHARLES
GRANITE CITY
E. ST. LOUIS
BELLEVILLE
ILLINOIS
MISSOURI
ST. CHARLES CO.
ST. LOUIS CO.
MADISON CO.
ST. CLAIR CO.
ST. LOUIS CO.
JEFFERSON CO.
ST. CLAIR CO.
MONROE CO.
0.010
0.010
0.010
0.010
0.020
0.030
0.040
LEGEND
BOUNDARIES
STATE
COUNTY
HIGHWAY MARKERS
FEDERAL
STATE
ISOPLETHS OF GEOMETRIC MEAN VALUES
LINES OF ACTUAL EQUAL VALUES
LINES OF PROBABLE EQUAL VALUES
BASED ON SEASONAL GEOMETRIC MEAN VALUES FOR 20 STATIONS DURING DEC. 1, 1963 TO FEB. 29, 1964.
820
810
800
790
780
770
760
750
740
730
720
710
700
690
680
670
660
650
640
630
620
610
600
590
580
390
400
410
420
430
440
450
460
470
480
490
500
510
520
530
540
550
560
570

Figure 92. Twenty-four-hour sulfur dioxide geometric means (ppm).

Figure 97 gives the frequency distributions for site 499-706, an industrial area, which had the highest average; 533-717, a rural area, which had the lowest average; 501-713, East St. Louis downtown area; 490-713, St. Louis downtown area;

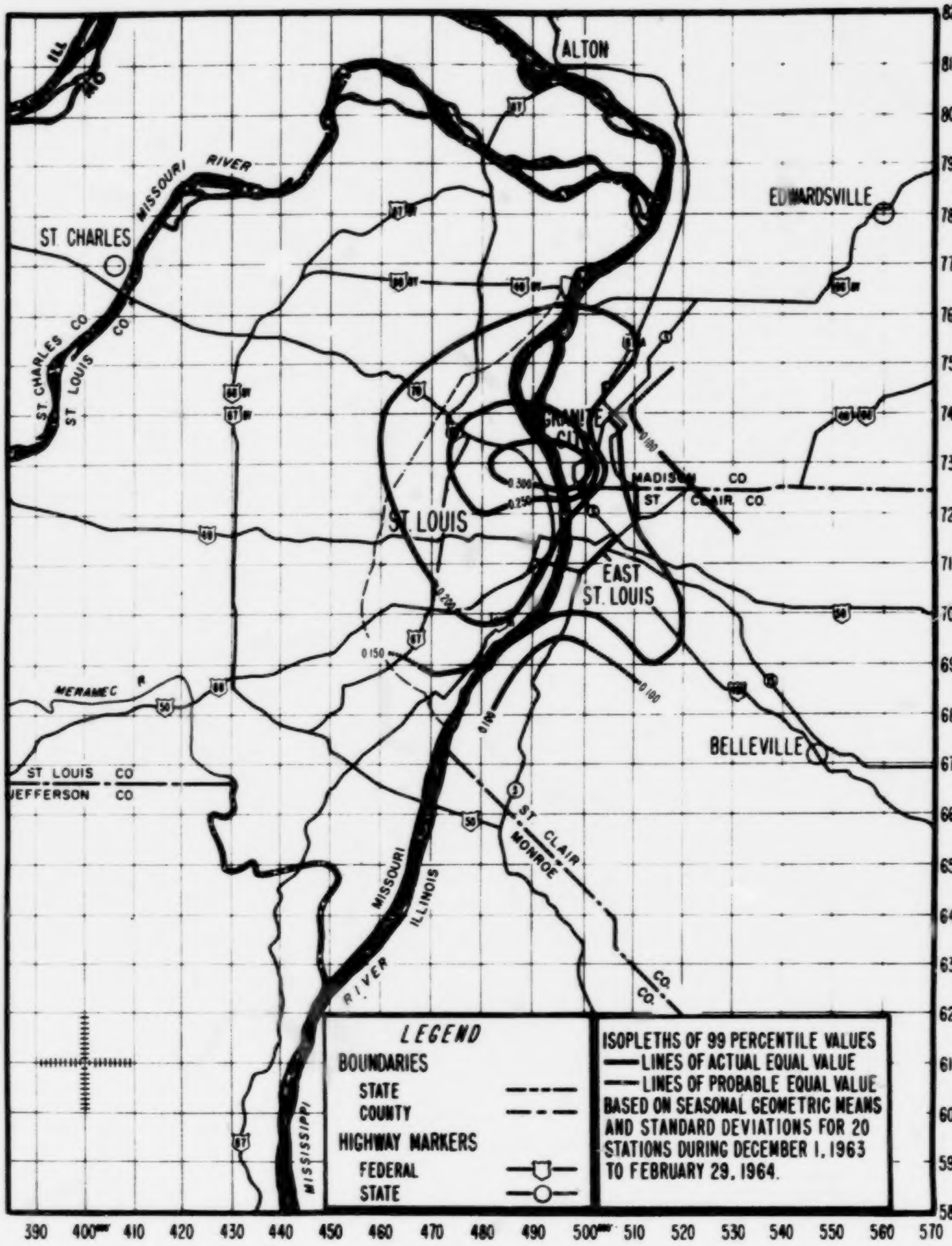

ALTON
ILL
MO
MISSOURI RIVER
ST CHARLES
EDWARDSVILLE
ST CHARLES CO
ST LOUIS CO
GRANITE CITY
MADISON CO
ST CLAIR CO
ST. LOUIS
EAST ST. LOUIS
MERAMEC R
BELLEVILLE
ST LOUIS CO
JEFFERSON CO
ST CLAIR
MONROE
CO.
CO.
MISSOURI
ILLINOIS
RIVER
MISSISSIPPI
0.300
0.250
0.200
0.150
0.100
0.100
0.100
0.100
LEGEND
BOUNDARIES
STATE
COUNTY
HIGHWAY MARKERS
FEDERAL
STATE
ISOPLETHS OF 99 PERCENTILE VALUES
LINES OF ACTUAL EQUAL VALUE
LINES OF PROBABLE EQUAL VALUE
BASED ON SEASONAL GEOMETRIC MEANS AND STANDARD DEVIATIONS FOR 20 STATIONS DURING DECEMBER 1, 1963 TO FEBRUARY 29, 1964.
820
810
800
790
780
770
760
750
740
730
720
710
700
690
680
670
660
650
640
630
620
610
600
590
580
390
400
410
420
430
440
450
460
470
480
490
500
510
520
530
540
550
560
570

Figure 93. Twenty-four-hour sulfur dioxide 99 percentile values (ppm).

and all 40 sites combined for the 1964-65 sulfur dioxide network of 24-hour samplers. These results indicate that the Colorado standard of 0.1 ppm for 24 hours

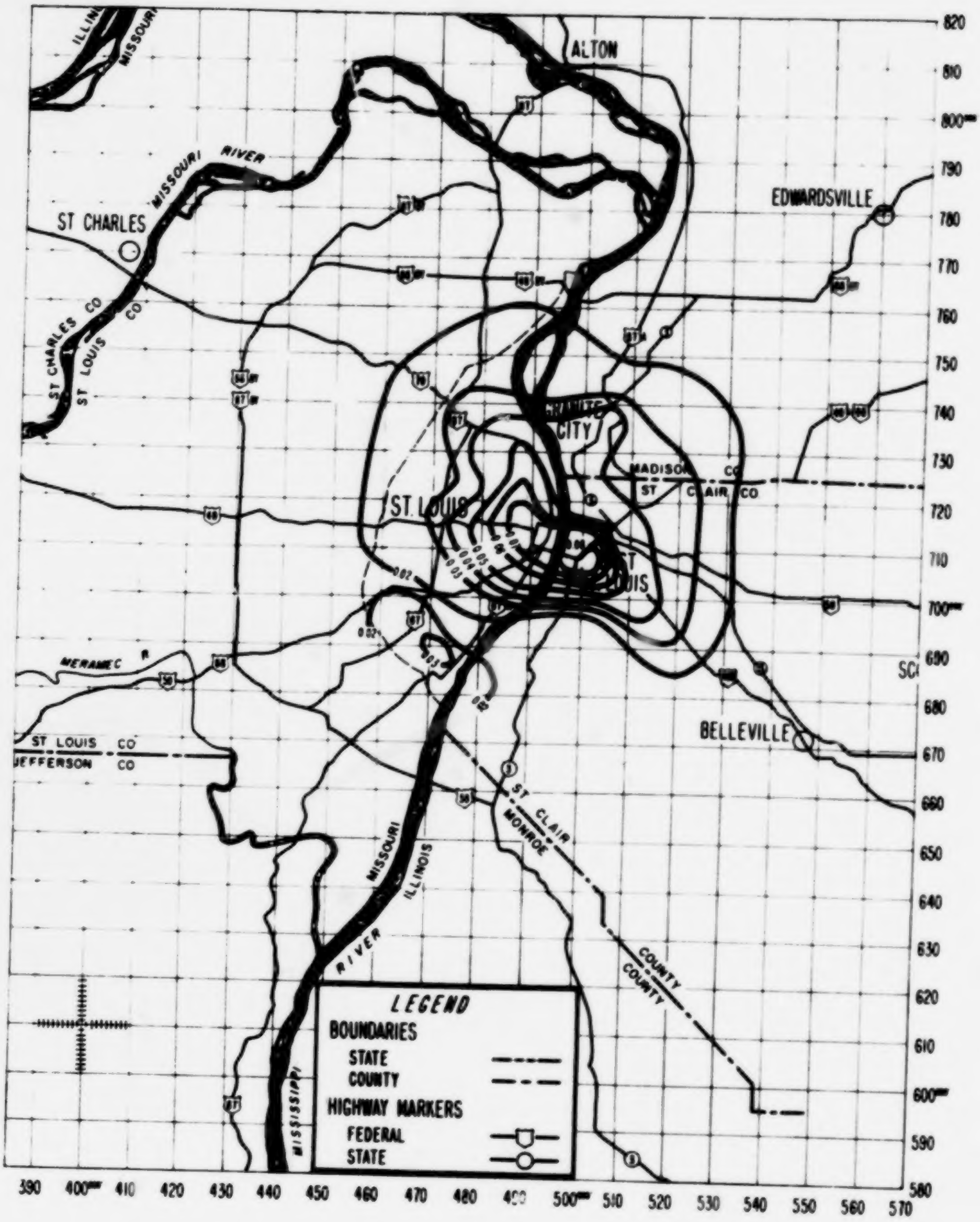

ALTON
EDWARDSVILLE
ST CHARLES
MISSOURI RIVER
ST CHARLES CO
ST LOUIS CO
GRANITE CITY
MADISON CO
ST CLAIR CO
ST. LOUIS
ST LOUIS
0.02
0.03
0.04
0.05
0.06
MERAMEC R
ST LOUIS CO
JEFFERSON CO
BELLEVILLE
ST CLAIR COUNTY
MONROE COUNTY
MISSOURI
ILLINOIS
RIVER
MISSISSIPPI
LEGEND
BOUNDARIES
STATE
COUNTY
HIGHWAY MARKERS
FEDERAL
STATE
390
400
410
420
430
440
450
460
470
480
500
510
520
530
540
550
560
570
580
590
600
610
620
630
640
650
660
670
680
690
700
710
720
730
740
750
760
770
780
790
800
810
820

Figure 94. Twenty-four-hour sulfur dioxide geometric means (ppm) for 40-station network during winter of 1964-65.

was exceeded 48 percent of the time at site 499-706, almost 1 percent of the time at site 533-717, and 10 percent of the time for all sites combined. Figure 98 gives

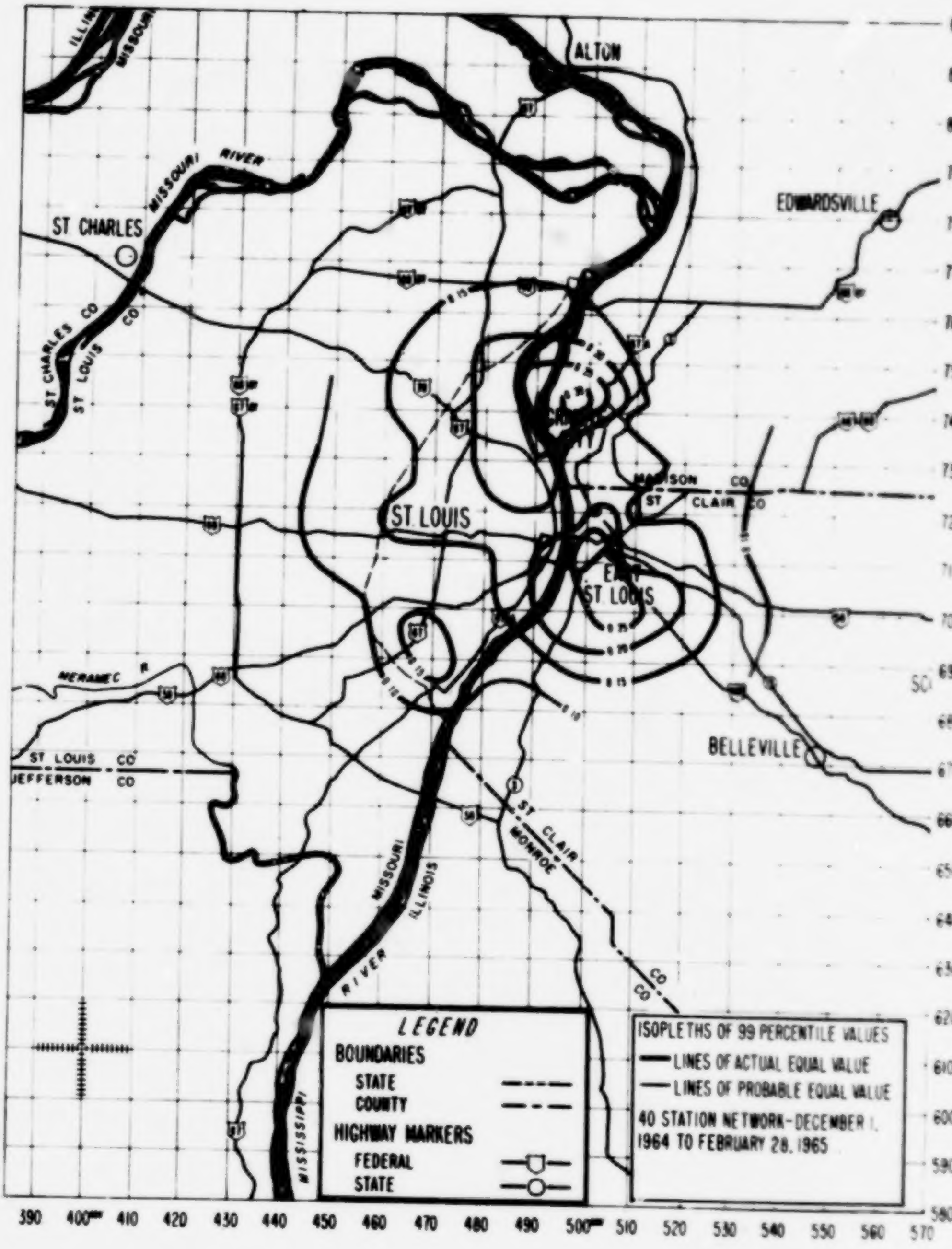

ALTON
EDWARDSVILLE
ST CHARLES
MISSOURI RIVER
ILLINOIS
MISSOURI
ST CHARLES CO
ST LOUIS CO
ST LOUIS
EAST ST LOUIS
MADISON CO
ST CLAIR CO
BELLEVILLE
MERAMEC R
ST LOUIS CO
JEFFERSON CO
ST CLAIR
MONROE
CO
CO
MISSOURI
ILLINOIS
RIVER
MISSISSIPPI
0.15
0.10
0.25
0.20
LEGEND
BOUNDARIES
STATE
COUNTY
HIGHWAY MARKERS
FEDERAL
STATE
ISOPLETHS OF 99 PERCENTILE VALUES
LINES OF ACTUAL EQUAL VALUE
LINES OF PROBABLE EQUAL VALUE
40 STATION NETWORK-DECEMBER 1, 1964 TO FEBRUARY 28, 1965
820
810
800
790
780
770
760
750
740
730
720
710
700
690
680
670
660
650
640
630
620
610
600
590
580
390
400
410
420
430
440
450
460
470
480
490
500
510
520
530
540
550
560
570

Figure 95. Twenty-four-hour sulfur dioxide 99 percentile values (ppm) for 40-station network during winter of 1964-65.

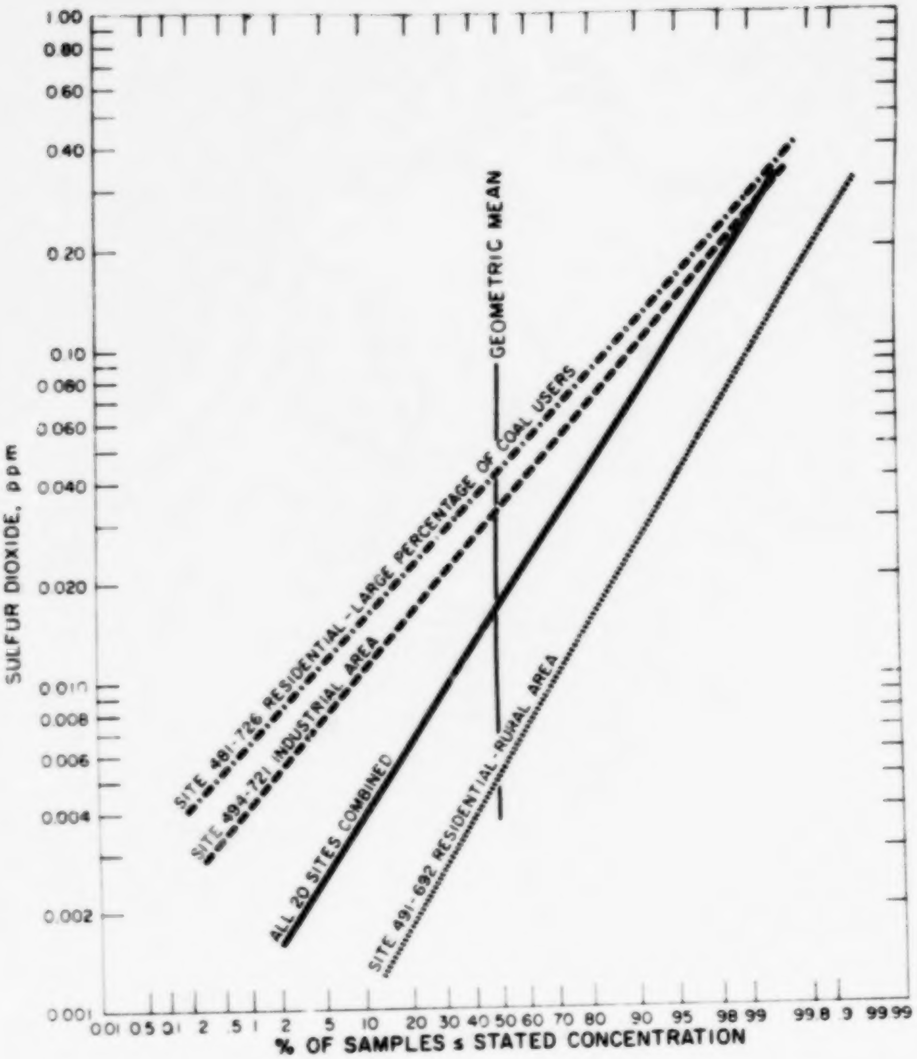


Figure 96. Twenty-four-hour sulfur dioxide frequency distribution (Dec 1963 - Feb 1964), geometric means.

the frequency distribution for sites 499-706, 490-713, 449-719, and all ten of the sites combined for the 1964-65 network of 2-hour sequential samplers. No present standards or objectives have been based on 2-hour results; therefore, no direct comparison can be made.

The diurnal variations given in Table 37 and Figure 99 indicate only minor variations in the sulfur dioxide concentrations during the day for sites 490-713, 449-719, and all ten sites combined. Site 499-706 showed much greater variations

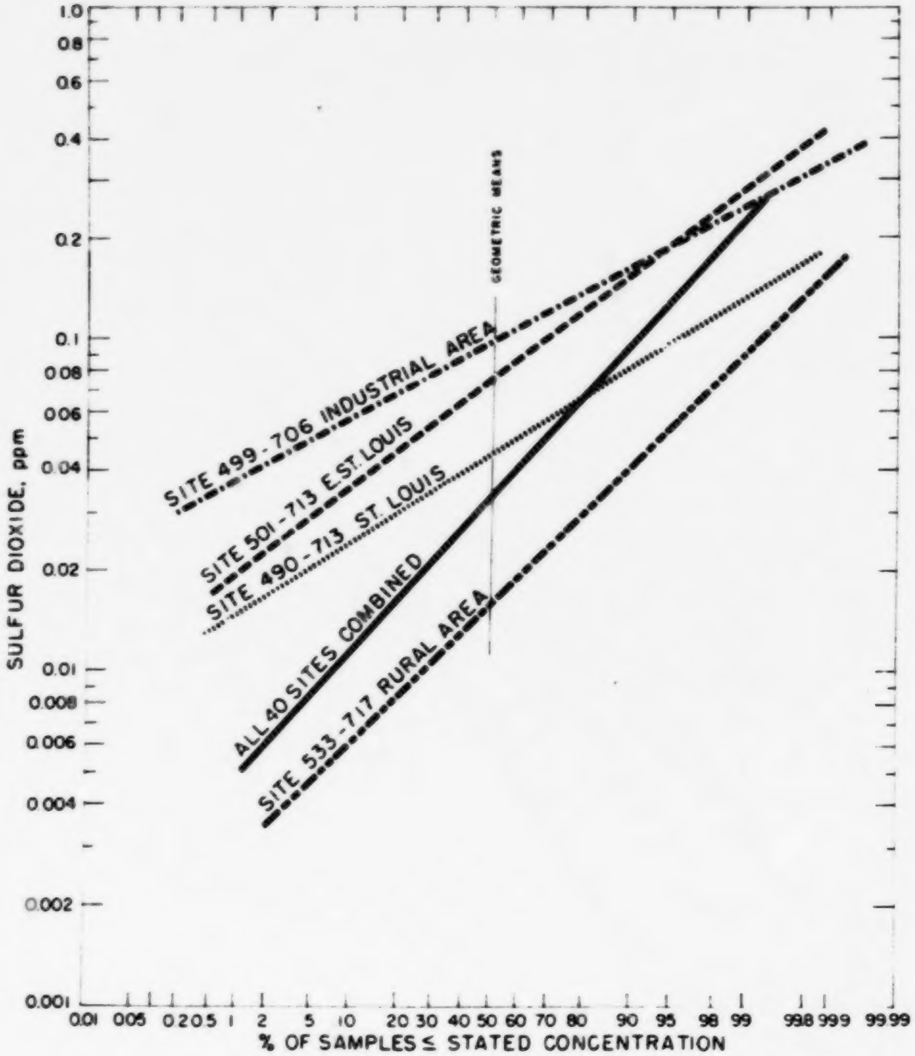


Figure 97. Twenty-four-hour samples - sulfur dioxide frequency distribution (Dec 1964 - Feb 1965).

with the peaks being between 2 to 4 a.m. and 6 to 8 p.m. Normal morning peaks around 6 to 8 a.m. reflect the increase of human activities in the morning. The 2 to 4 a.m. peak may indicate an industrial influence or a meteorologic-topographic influence.

The pollution roses for the twenty 24-hour sampler stations used in the 1963-64 network are shown in Figures 100 through 119. The roses indicate the central metropolitan area as the primary source of the sulfur dioxide. Certain industrial areas also contribute a significant portion.

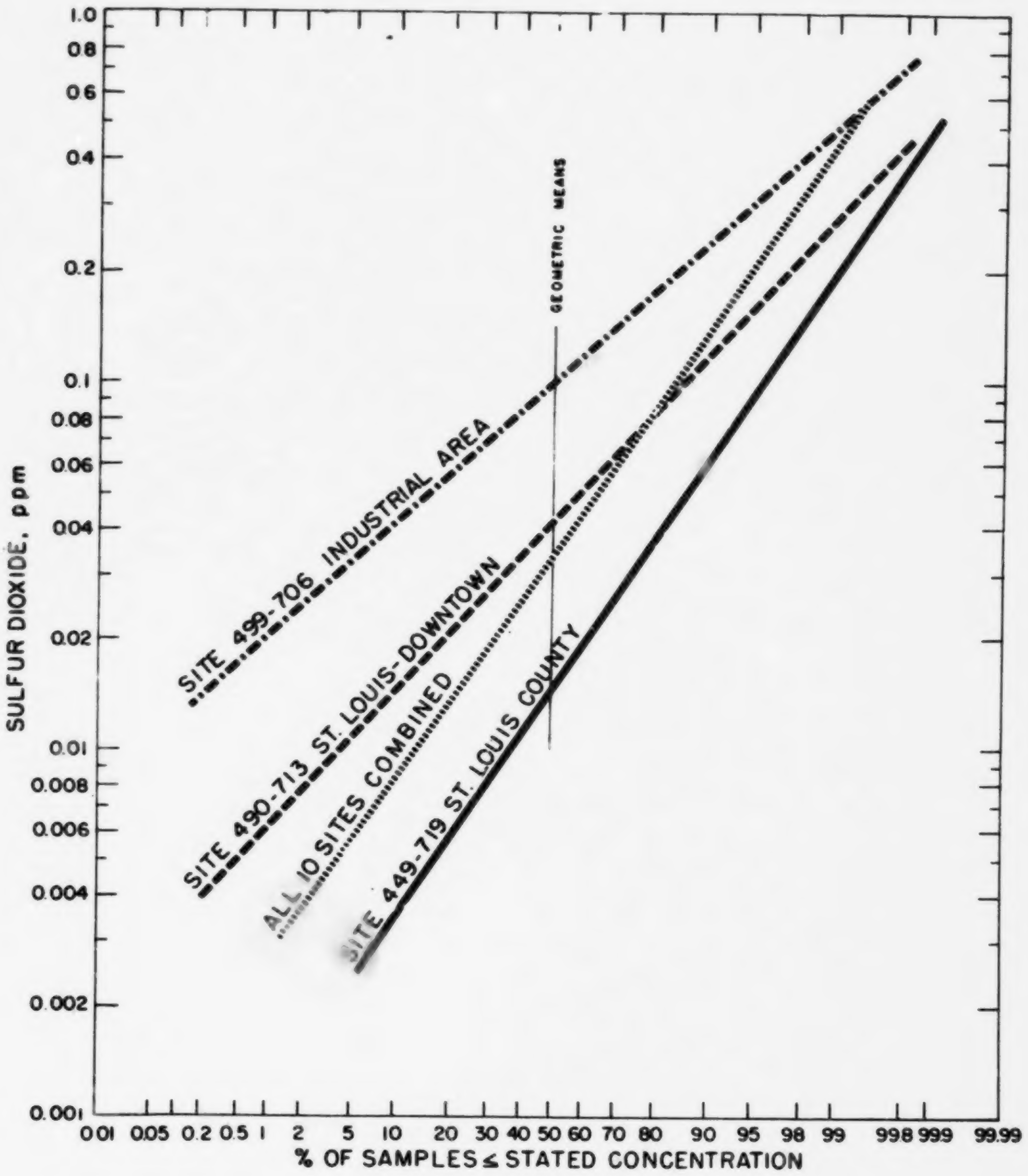


Figure 98. Two-hour sequential sulfur dioxide frequency distribution (Dec 1964 - Feb 1965).

To indicate the importance of directional influence on sulfur dioxide levels and to provide a guide for design of the air use plan, a directional analysis was made from sulfur dioxide data collected during the 1963-64 winter season. The basic data appear on pollution rose computer printouts (not included in this report) and on pollution roses, which are part of this report. The method used is the same

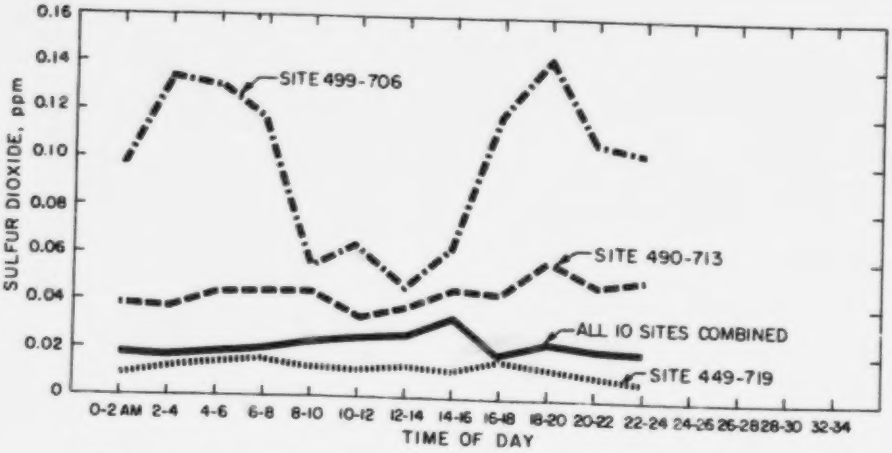


Figure 99. Diurnal variations of sulfur dioxide (Dec 1964 - Feb 1965).

Table 37. DIURNAL VALUES FOR 2-HOUR SULFUR DIOXIDE, DECEMBER 1964 - FEBRUARY 1965

Daily time interval, hr	Site coordinates										
	449-719	468-724	479-738	481-696	490-713	498-729	499-706	509-710	509-751	527-702	All
	SO_2 concentration, ppm										
0-2	0.009	0.041	0.032	0.031	0.038	0.049	0.097	0.033	0.018	0.017	0.017
2-4	0.012	0.064	0.017	0.029	0.037	0.039	0.134	0.044	0.017	0.017	0.017
4-6	0.013	0.086	0.024	0.026	0.043	0.048	0.130	0.054	0.017	0.019	0.019
6-8	0.015	0.098	0.032	0.017	0.043	0.057	0.116	0.055	0.016	0.020	0.020
8-10	0.012	0.091	0.027	0.017	0.044	0.050	0.055	0.066	0.016	0.023	0.023
10-12	0.011	0.055	0.021	0.016	0.033	0.039	0.064	0.065	0.015	0.025	0.025
12-14	0.012	0.060	0.024	0.018	0.037	0.033	0.047	0.056	0.010	0.025	0.025
14-16	0.011	0.083	0.029	0.019	0.045	0.032	0.062	0.057	0.014	0.033	0.033
16-18	0.016	0.101	0.017	0.020	0.043	0.052	0.119	0.058	0.015	0.018	0.018
18-20	0.013	0.080	0.019	0.018	0.058	0.038	0.142	0.060	0.017	0.024	0.024
20-22	0.011	0.058	0.030	0.016	0.048	0.051	0.107	0.051	0.015	0.021	0.021
22-24	0.006	0.045	0.025	0.019	0.050	0.044	0.104	0.040	0.013	0.020	0.020

as that used for suspended particulates (collected by high-volume sampler). The tentative goal used for method-demonstration purposes is 0.04-ppm 24-hour average not to be exceeded over 1 percent of the time, 99th percentile value. The background is considered to be zero. A map, Figure 120, shows the results of the analysis.

This directional analysis supports the observations drawn from the pollution roses and directly confirming that the central part of the study area has considerable effect on sulfur dioxide levels in outlying areas and points to the areas having

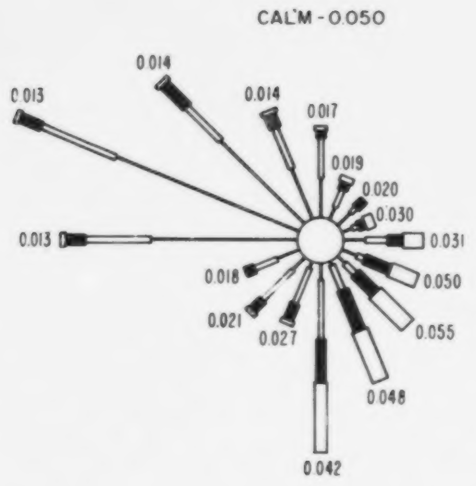


Figure 100. Sulfur dioxide pollution rose - site No. 466-742 72 samples.

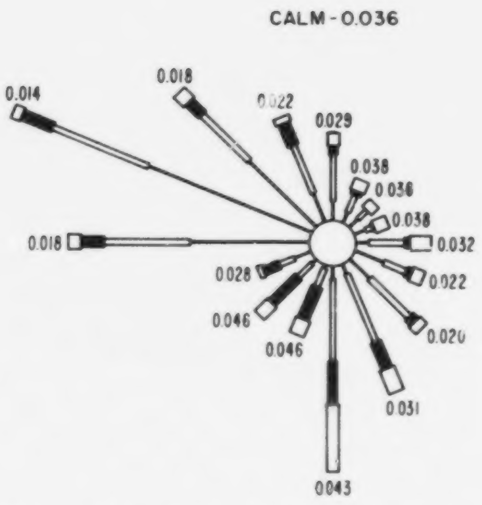
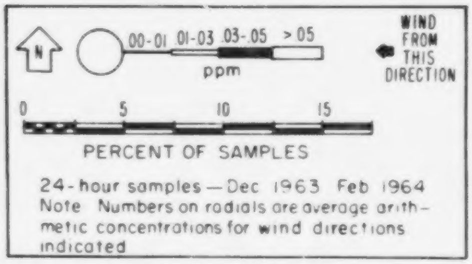


Figure 101. Sulfur dioxide pollution rose - site No. 471-689 75 samples.


N
00-01
01-03
.03-.05
>05
ppm
WIND FROM THIS DIRECTION
0
5
10
15
PERCENT OF SAMPLES

24-hour samples — Dec 1963 Feb 1964
Note Numbers on radials are average arithmetic concentrations for wind directions indicated

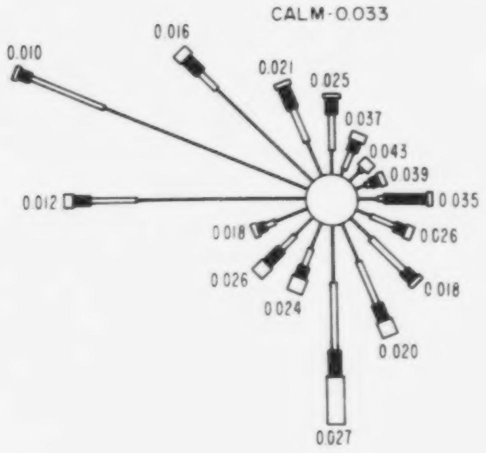


Figure 102. Sulfur dioxide pollution rose - site No. 472-707 73 samples.

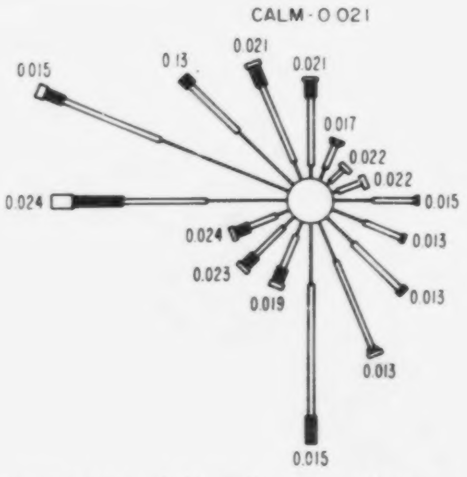


Figure 103. Sulfur dioxide pollution rose - site No. 480-682 66 samples.

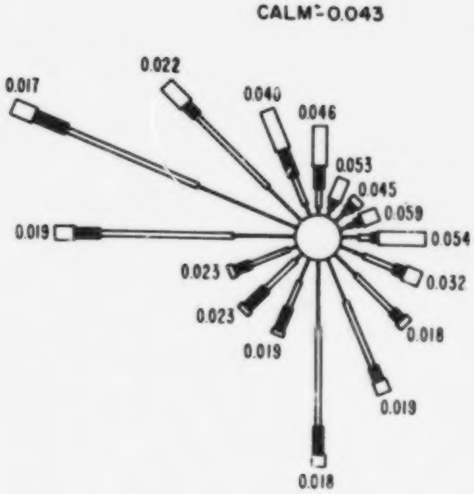


Figure 104. Sulfur dioxide pollution rose - site No. 481-696 74 samples.

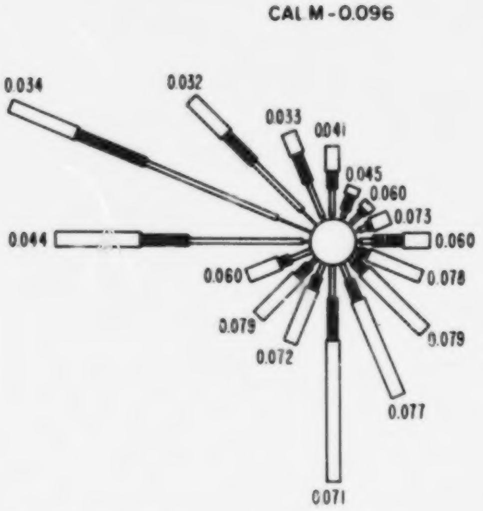
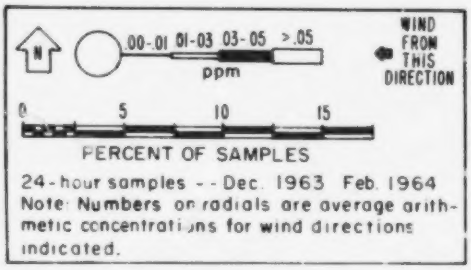


Figure 105. Sulfur dioxide pollution rose - site No. 481-726 72 samples.


N
.00-.01
.01-.03
.03-.05
>.05
ppm
WIND FROM THIS DIRECTION
0
5
10
15
PERCENT OF SAMPLES

24-hour samples -- Dec. 1963 Feb. 1964
Note: Numbers on radials are average arithmetic concentrations for wind directions indicated.

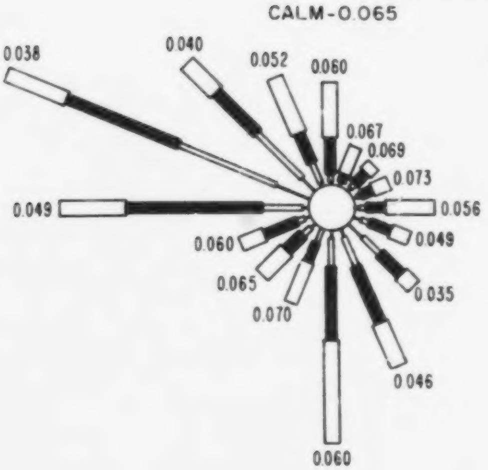


Figure 106. Sulfur dioxide pollution rose - site No. 487-706 73 samples.

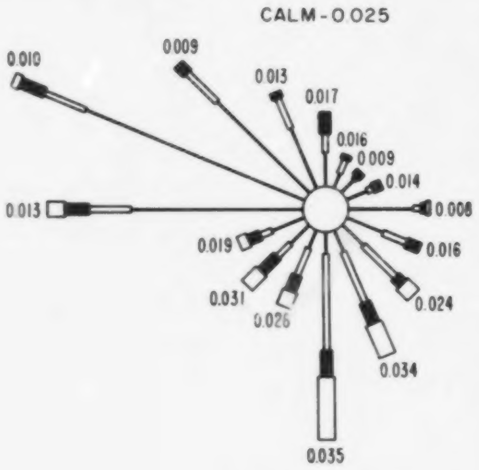


Figure 107. Sulfur dioxide pollution rose - site No. 490-759 74 samples.

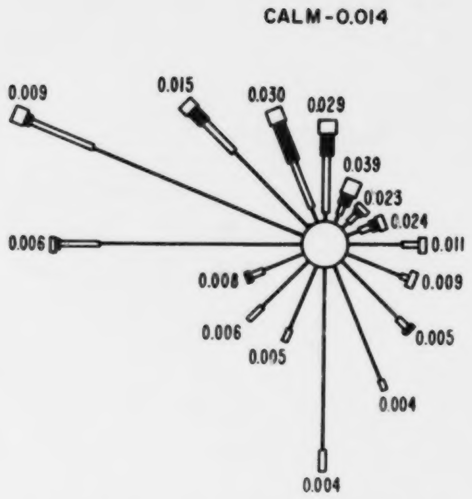


Figure 108. Sulfur dioxide pollution rose - site No. 491-692 76 samples.

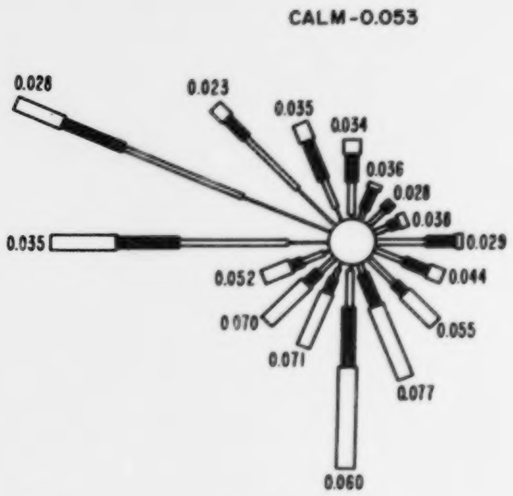
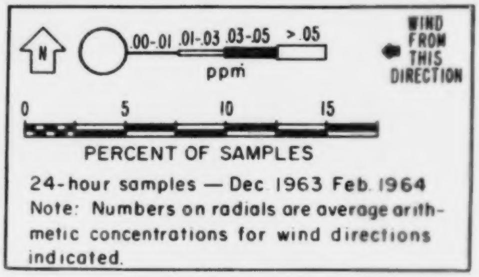


Figure 109. Sulfur dioxide pollution rose - site No. 494-721 67 samples.


N
.00-.01
.01-.03
.03-.05
>.05
ppm
WIND FROM THIS DIRECTION
0
5
10
15
PERCENT OF SAMPLES

24-hour samples — Dec 1963 Feb 1964
Note: Numbers on radials are average arithmetic concentrations for wind directions indicated.

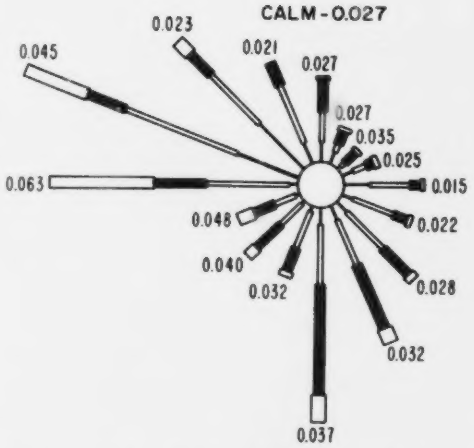


Figure 110. Sulfur dioxide pollution rose - site No. 498-718 66 samples.

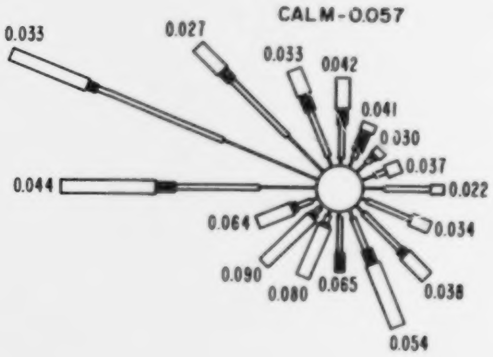


Figure 111. Sulfur dioxide pollution rose - site No. 498-729 70 samples.

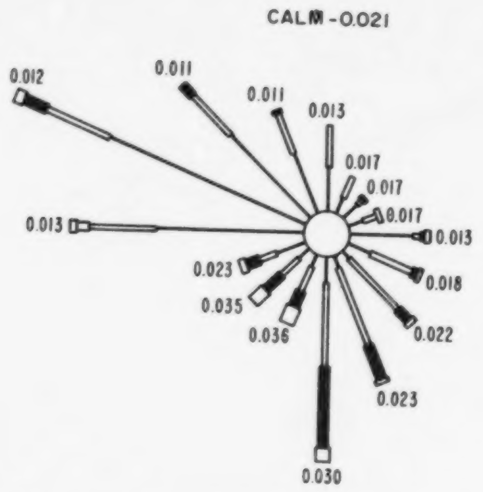


Figure 112. Sulfur dioxide pollution rose - site No. 499-743 74 samples.

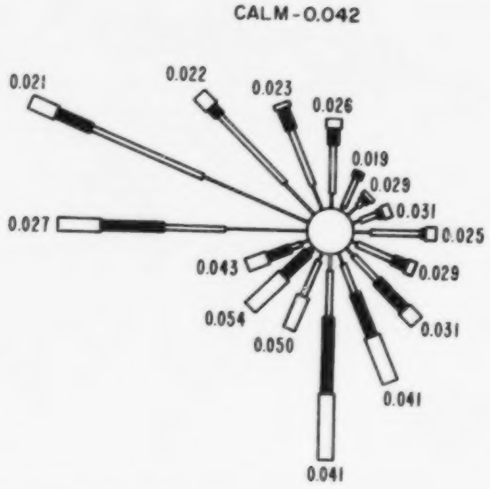
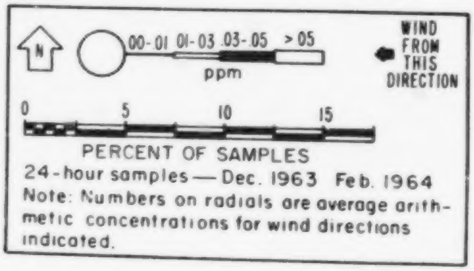


Figure 113. Sulfur dioxide pollution rose - site No. 502-736 72 samples.


N
00-01
01-03
.03-05
>05
ppm
WIND FROM THIS DIRECTION
0
5
10
15
PERCENT OF SAMPLES

24-hour samples — Dec. 1963 Feb. 1964

Note: Numbers on radials are average arithmetic concentrations for wind directions indicated.

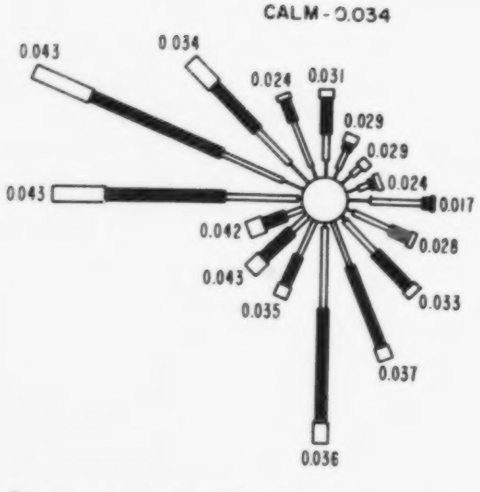


Figure 114. Sulfur dioxide pollution rose - site No. 503-723 70 samples.

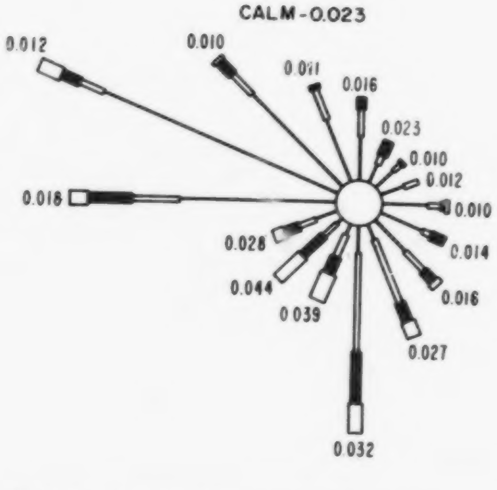


Figure 115. Sulfur dioxide pollution rose - site No. 509-751 71 samples.

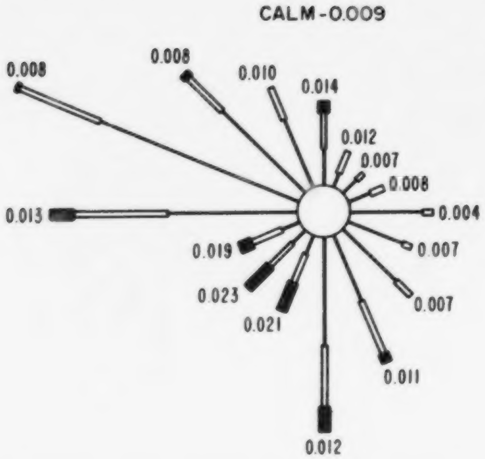


Figure 116. Sulfur dioxide pollution rose - site No. 513-742 71 samples.

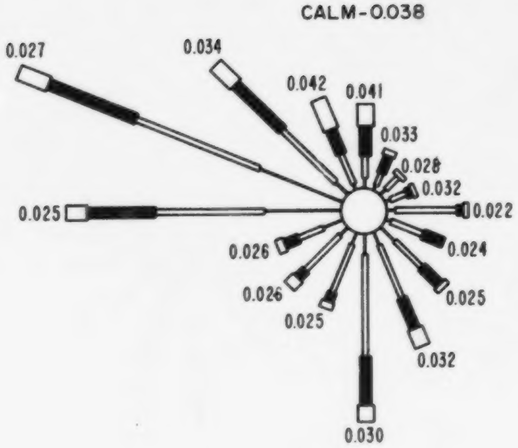
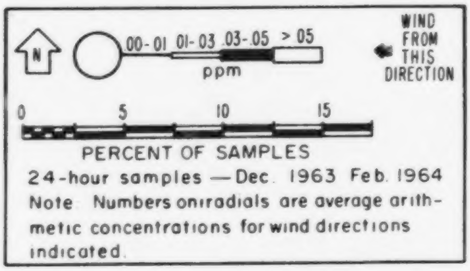


Figure 117. Sulfur dioxide pollution rose - site No. 515-690 66 samples.


N
00-01
01-03
.03-05
> 05
ppm
WIND FROM THIS DIRECTION
0
5
10
15
PERCENT OF SAMPLES

24-hour samples — Dec. 1963 Feb. 1964

Note: Numbers on radials are average arithmetic concentrations for wind directions indicated.

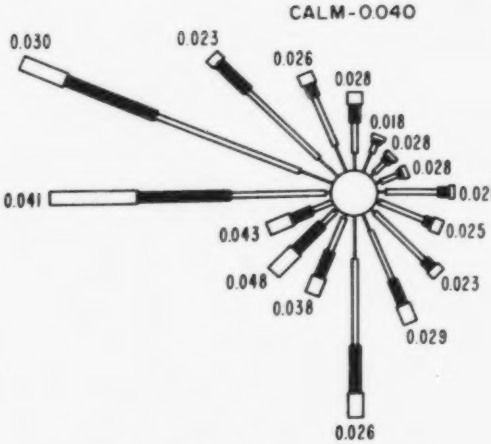


Figure 118. Sulfur dioxide pollution rose - site No. 518-716 73 samples.

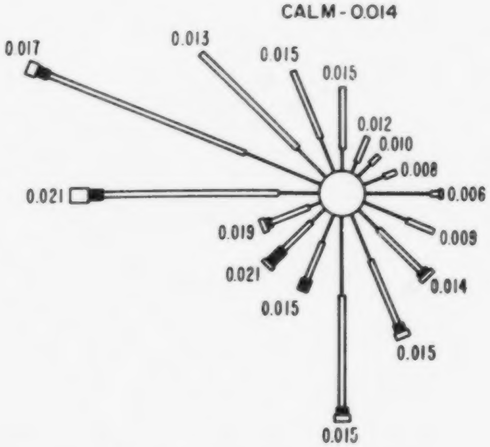
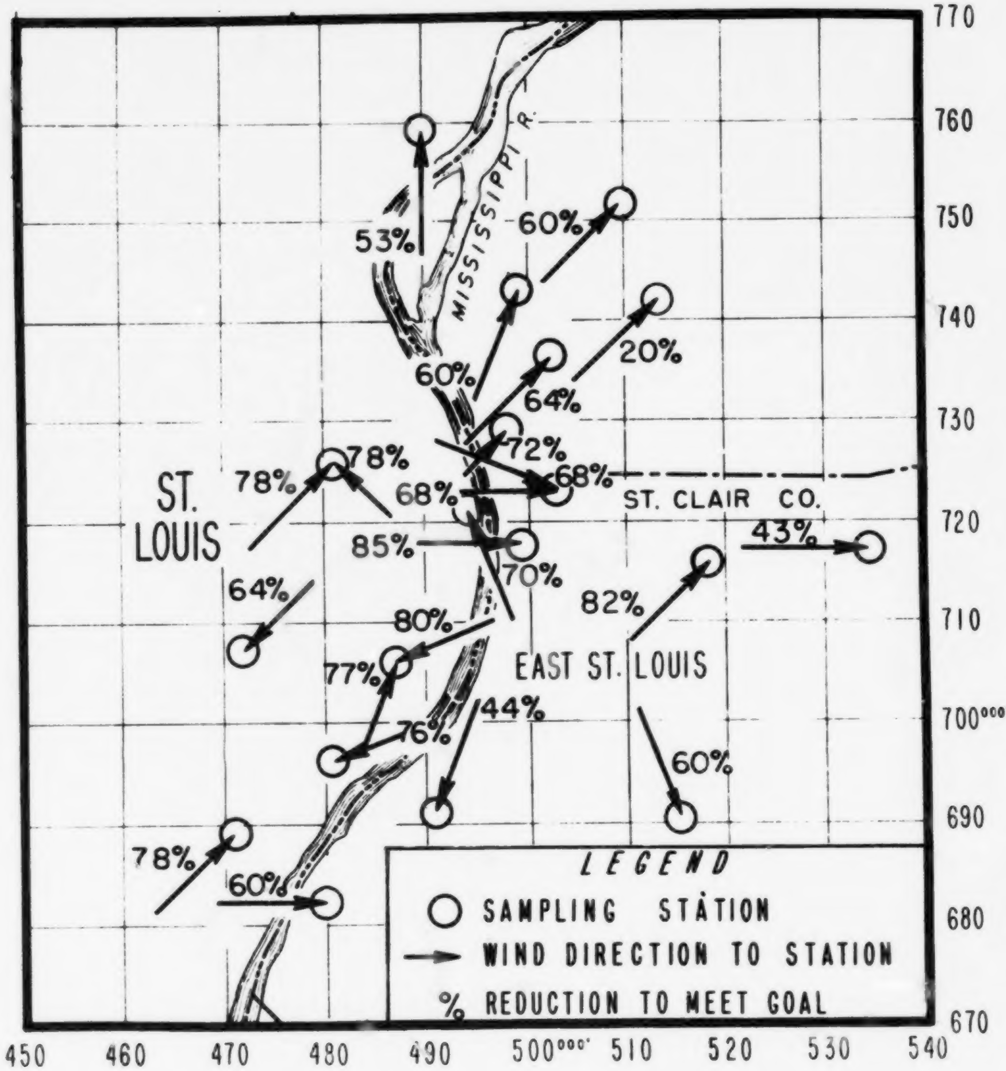


Figure 119. Sulfur dioxide pollution rose - site No. 533-717 74 samples.



770
760
750
740
730
720
710
700000'
690
680
670
450
460
470
480
490
500000'
510
520
530
540
MISSISSIPPI R.
ST. LOUIS
EAST ST. LOUIS
ST. CLAIR CO.
53%
60%
60%
20%
64%
72%
78%
78%
68%
68%
85%
70%
43%
82%
64%
80%
77%
76%
44%
60%
78%
60%
LEGEND
SAMPLING STATION
WIND DIRECTION TO STATION
% REDUCTION TO MEET GOAL

Figure 120. Directions of maximum sulfur dioxide influence on stations and direction-percent reduction needed.

the greatest sulfur dioxide source strength as being in the East St. Louis area and the area to the southwest of Granite City. In St. Louis, grid square 480-720 appears to be subjected to equally strong sources on more than one side, possibly from home heating with coal or sources with tall stacks at some distance.

The results of the correlation of sulfur dioxide concentrations from the 1963-64 network and stability classes are given in Table 38. The minimum concentrations occurred for stability class 4 at 19 of the 20 stations, with the maximum concentrations equally divided among classes 2, 3, and 5. These results are similar

Table 58: AVERAGE 24-HOUR SULFUR DIOXIDE CONCENTRATION FOR FIVE ATMOSPHERIC STABILITY CLASSES
DECEMBER 1963 - FEBRUARY 1964

Site coordinates	Atmospheric stability class[a]				
	1	2	3	4	5,6,7
	Average SO_2 concentration, ppm				
466-742	--	0.029	0.029	0.024	0.030
471-689	--	0.029	0.035	0.022	0.033
472-707	--	0.030	0.028	0.016	0.025
480-682	--	0.026	0.021	0.014	0.021
481-696	--	0.050	0.035	0.022	0.030
481-726	--	0.070	0.069	0.047	0.069
487-706	--	0.059	0.059	0.046	0.058
490-759	--	0.017	0.021	0.017	0.021
491-692	--	0.020	0.015	0.011	0.012
494-721	--	0.047	0.049	0.039	0.050
498-718	--	0.029	0.033	0.037	0.035
498-729	--	0.050	0.056	0.038	0.054
499-743	--	0.017	0.022	0.016	0.021
502-736	--	0.036	0.036	0.028	0.037
503-723	--	0.036	0.040	0.034	0.038
509-751	--	0.021	0.024	0.017	0.024
513-742	--	0.010	0.012	0.010	0.013
515-690	--	0.032	0.033	0.028	0.032
518-716	--	0.036	0.036	0.026	0.038
533-717	--	0.016	0.015	0.015	0.016

[a] 1 = extremely unstable.
2 = unstable.
3 = slightly unstable.
4 = neutral.
5,6,7 = slightly stable, stable, and extremely stable.

to those obtained for the AISI sampler; they indicate that high wind speeds rather than high thermal mixing result in the lower concentrations.

An attempt was made to demonstrate the influence of a "heat island" effect by plotting stability classes for station maximum levels on a map. The expected order if there were no "heat island" effect would place maximum levels at the upper end of the scale (7) and minimum levels at the lower end (1). A consistent change from the expected pattern across the air pollution basin would be indicative of "heat island" effects. The results did not show a consistent pattern, possibly because of the overriding influences of wind speed and source strength-direction. Although not included in this report, these results are mentioned to prevent duplication of effort by others who may use these data.

In addition to the high-volume air samplers, the National Air Sampling Network has operated sulfur dioxide samplers in some of the larger metropolitan areas. The results from St. Louis and some other cities for 1963 are given in Table 18. Of the 14 cities listed, four had arithmetic means above that for St. Louis, which was equal to that of two other cities. The St. Louis mean was somewhat below the average for the 14.

The trend of sulfur dioxide concentrations in the St. Louis area since 1936 is given in Table 39. It is easy to see from these figures that the concentrations in 1963-64 and 1964-65 were considerably lower than in 1936-37. The major portion of this reduction occurred as a result of:

1. Required use of low volatile coal (lower in sulfur also) in St. Louis hand-fired units. Ordinance 41804, 1940.
2. Required use of washed stoker fuels. Ordinance 41804, 1940 (washing required if ash content exceeded 12 percent or sulfur content 2 percent. Washing removes large percent of pyrites).
3. Change from coal to a fuel of lesser sulfur content (influenced by 1 and 2 and availability of gas at competitive prices).

HYDROGEN SULFIDE

Hydrogen sulfide data were obtained at sites 505-740 and 510-742 (not a network site) during September, October, and November 1964. These results are given in Tables 40 and 41. Odor threshold levels reported for hydrogen sulfide vary from 10 to 100 parts per billion (ppb). Hydrogen sulfide is very obnoxious to humans. Under certain meteorological conditions, it causes significant damage to lead-base paints at a concentration of approximately 100 ppb.[19]

The State of New York ambient air quality objective for hydrogen sulfide is 100 ppb for 1 hour,[7] which is the same as the California standard.[19] The U.S.S.R. has established a much lower standard of 5 ppb for 24 hours.[20] The Terre Haute, Indiana report of June 1964 suggests a goal of 50 ppb[21] for 1 hour.

The highest hydrogen sulfide measurement made during this Study was 62.5 ppb, a 2-hour average, which could but probably does not exceed the New York or California

Table 39. SULFUR DIOXIDE TREND IN ST. LOUIS AREA SINCE 1936

	No. of stations	No. of samples	Max. concentration, ppm	Avg concentration, ppm
October 12, 1936 - April 25, 1937[66]	52	2319	2.266	0.180
February - March 1950[67]	9	243	0.51	0.041
April 7 - April 14, 1954[68]	1	49	0.17	0.06
NASN, 1962[69]	1	23	0.12	0.05
NASN, 1963[62]	1	26	0.10	0.02
December 1963 - February 1964	20	1429	0.24	0.028
December 1964 - February 1965	40	3338	0.26	0.045

Table 40. HYDROGEN SULFIDE DATA FROM SITE NO. 505-740 (ppb)

Date, 1964	Time											
	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18	18-20	20-22	22-24
Sept 17	-	-	-	-	1.8	4.0	1.4	1.2	2.2	1.8	0.9	0.9
18	2.0	2.4	0.9	1.4	2.2	2.2	1.6	1.8	1.6	2.6	3.8	4.8
19	5.0	4.5	3.8	6.1	3.3	1.6	1.0	0.7	1.2	2.4	0.7	2.8
20	2.4	1.8	1.6	1.2	1.8	1.0	0.9	0.7	2.0	1.2	0.9	2.6
21	2.0	3.5	1.4	2.2	0.9	1.8	2.4	1.8	2.0	2.6	2.6	3.1
22	1.8	3.5	0.9	1.0	1.4	1.0	1.2	1.2	2.2	4.0	1.8	1.2
23	1.8	1.8	2.2	2.0	1.4	1.8	1.2	1.4	1.8	2.2	1.2	1.8
24	1.4	1.6	1.4	2.6	3.1	2.6	3.4	3.3	2.6	1.8	2.0	2.2
25	13.2	1.0	3.1	0.7	4.0	2.6	2.8	3.3	2.2	2.4	2.6	2.4
26	2.6	3.1	2.2	2.2	2.8	2.6	2.6	1.4	1.2	1.2	1.4	1.2
27	1.4	0.7	0.7	0.4	0.0	0.5	1.0	1.4	1.0	1.2	0.7	1.0
28	1.4	1.0	0.7	0.7	1.0	1.0	1.2	1.2	0.7	1.0	1.8	3.3
29	3.1	3.1	1.0	2.8	2.8	2.2	0.7	1.0	0.7	0.7	1.0	0.7
30	0.7	0.7	0.4	0.7	1.4	0.9	1.2	1.4	1.0	1.8	1.4	2.8
Oct 1	1.2	2.2	-	-	-	-	-	-	-	-	-	-
Max	13.2	4.5	3.8	6.1	4.0	4.0	3.1	3.3	2.6	4.0	3.8	4.8
Min	0.7	0.7	0.4	0.4	0.0	0.5	0.7	0.7	0.7	0.7	0.7	0.7
No.	14	14	13	13	14	14	14	14	14	14	14	14
Avg	2.9	2.2	1.6	1.8	2.0	1.8	1.6	1.6	1.6	1.6	1.6	2.2

Table 41. HYDROGEN SULFIDE DATA FROM SITE NO. 510-742 (ppb)

Date, 1964	Time											
	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18	18-20	20-22	22-24
Sept. 1									0.5	0.9	1.2	1.4
2	1.2	1.0	0.9	1.8	1.4	2.6	1.6	1.4	13.6	20.4	4.8	10.7
3	3.1	7.7	33.5	10.4	5.0	2.6	1.8	2.9	3.1	4.5	3.1	2.4
4	2.4	3.1	2.6	1.0	1.6	0.7	0.5	0.9	1.0	2.4	3.1	1.4
5	1.0	1.4	1.0	1.0	0.4	1.0	1.0	1.0	0.9	1.2	1.2	1.0
6	1.8	1.4	1.4	2.2	5.0	6.6	7.7	10.4	17.5	41.2	41.2	30.0
7	36.3	58.5	37.6	47.0	47.0	5.0	4.5	4.0	9.0	24.6	3.1	4.0
8	3.1	13.2	43.0	3.8	39.3	3.5	3.1	2.8	2.8	3.1	3.3	3.5
9	3.3	2.4	4.0	3.5	3.3	2.8	1.8	1.8	1.4	1.4	2.0	2.8
10	2.2	9.7	3.5	3.5	2.8	3.1	2.8	3.8	1.8	1.8	1.0	1.8
11	1.8	1.2	1.4	2.8	1.8	1.4	1.8	1.0	1.0	1.2	1.0	1.0
12	1.4	1.4	0.9	0.9	1.4	1.8	1.4	1.8	1.6	0.9	1.2	1.8
13	1.0	1.0	1.2	1.0	1.4	0.7	1.6	1.4	1.6	1.8	1.4	1.4
14	1.0	1.4	2.2	1.8	1.8	1.6	1.8	4.0	2.8	5.3	6.9	4.5
15	4.5	4.0	2.2	2.6	1.8	3.1	2.0	2.0	4.0	3.1	3.1	2.6
16	3.1	3.5	-	-	-	-	-	-	-	-	-	-
18	1.8	2.8	3.5	1.8	1.6	1.4	1.8	4.0	4.0	2.2	2.6	4.5
19	3.1	3.5	4.0	2.2	1.4	0.9	1.8	2.2	5.6	1.8	5.0	7.2
20	23.0	62.5	2.8	3.1	2.2	1.8	2.6	3.5	4.0	4.0	2.8	2.8
21	1.4	0.4	3.1	4.0	2.2	1.8	4.0	17.5	39.3	3.1	3.1	-
Oct. 1	-	-	-	-	-	1.8	1.8	2.4	4.8	7.2	1.2	0.7
2	1.2	1.4	1.2	1.6	1.4	0.7	0.7	0.4	0.7	1.0	0.4	1.4
3	2.0	3.3	5.3	7.2	5.0	0.9	0.4	1.4	0.7	1.4	1.0	2.4
4	0.7	0.4	1.0	0.5	0.7	1.0	0.0	0.0	0.2	0.7	0.4	0.4
5	0.4	0.5	0.4	1.4	1.4	0.0	0.9	0.0	1.0	1.8	0.9	1.0
6	1.2	1.6	0.7	0.7	0.5	1.0	1.2	1.2	1.6	1.0	2.6	3.1
7	0.7	1.2	1.2	1.6	2.6	2.6	1.6	1.2	0.7	0.5	1.0	1.4
8	0.0	1.2	1.2	1.8	1.4	1.4	2.0	1.0	2.2	1.8	1.8	0.4
9	0.4	1.2	0.5	0.7	0.5	1.0	1.0	0.5	0.5	0.5	0.7	1.8
10	1.2	0.9	1.0	3.1	1.0	0.5	0.0	0.0	1.0	1.8	0.7	0.7
11	2.4	3.1	1.8	1.2	1.6	0.7	0.0	0.9	1.4	1.4	1.8	1.8
12	2.2	2.6	2.2	2.6	3.5	2.0	1.2	0.9	0.5	1.0	0.9	1.0
13	1.0	0.5	1.0	1.0	1.8	1.0	0.0	0.4	0.9	1.0	1.0	2.2
14	1.0	0.9	0.5	2.2	1.8	1.8	-	-	-	-	-	-
15	-	-	-	-	-	0.7	1.2	0.2	0.5	1.0	1.0	1.8
16	1.4	1.8	1.0	2.8	2.2	2.2	0.9	0.7	1.4	1.4	6.1	5.4
17	6.6	5.6	5.0	4.0	6.1	4.5	1.4	2.0	1.4	2.0	2.6	3.1
18	4.2	2.2	0.4	0.4	0.2	0.5	0.4	0.7	0.7	0.7	1.0	1.0

Table 41. (Cont'd) HYDROGEN SULFIDE DATA FROM SITE NO. 510-742 (ppb)

Date, 1964	Time											
	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18	18-20	20-22	22-24
Oct. 19	0.7	1.0	0.2	1.4	0.7	0.7	0.7	0.7	0.7	0.9	0.5	0.4
20	0.2	0.4	0.7	1.0	1.0	1.0	0.7	0.9	0.7	1.0	1.0	1.4
21	1.0	1.0	0.7	0.7	0.7	0.5	0.5	1.2	0.5	0.5	0.2	0.2
22	0.5	0.2	0.0	1.0	1.4	0.9	0.5	0.2	0.5	1.2	0.5	0.7
23	1.4	0.9	1.0	1.4	1.2	0.7	1.0	1.0	1.0	1.4	2.2	2.8
24	3.3	3.3	2.8	4.5	4.8	1.0	0.5	0.7	1.4	2.4	1.8	0.9
25	1.2	1.2	1.8	1.8	2.2	1.2	0.7	1.0	0.7	1.6	1.2	2.8
26	3.1	1.0	1.4	2.2	2.2	2.2	2.2	1.8	2.8	2.2	2.6	3.1
27	1.4	0.9	0.9	1.2	1.2	2.6	1.8	1.4	1.0	1.2	2.2	2.2
28	2.2	1.0	1.2	2.4	2.2	1.8	0.9	0.7	0.7	0.7	2.6	2.6
29	2.6	1.8	1.4	1.2	1.2	1.2	1.2	0.7	0.7	0.7	0.4	0.7
30	0.7	1.0	1.0	1.8	1.4	1.4	1.0	1.0	1.6	1.8	1.6	1.4
31	1.6	1.2	1.0	1.2	1.2	0.4	0.7	0.4	1.4	2.2	2.2	2.2
Nov. 1	2.2	3.1	3.1	2.4	1.0	1.4	1.8	1.4	1.4	1.0	0.9	0.7
2	1.2	1.2	0.7	0.7	1.2	1.4	2.6	1.4	2.2	3.1	4.0	1.8
3	2.0	1.4	3.5	8.4	3.1	1.0	1.0	0.7	0.7	1.0	3.1	2.6
4	1.2	1.4	1.8	1.8	2.8	4.0	1.2	0.4	0.9	1.8	3.1	5.0
5	2.2	0.7	-	-	-	-	-	-	-	-	-	-
Max.	36.3	62.5	43.0	47.0	47.0	6.6	7.7	17.5	39.3	41.2	41.2	30.0
Min.	0.0	0.2	0.0	0.4	0.2	0.0	0.0	0.0	0.2	0.5	0.2	0.2
No.	53	53	51	51	51	53	52	52	53	53	53	52
Avg	2.9	4.4	3.9	3.2	3.6	1.7	1.5	1.8	2.9	3.3	2.8	2.9

standards. It does exceed the Terre Haute suggested goal. On 7 days, concentrations of 10 ppb or greater were measured at site 510-742. The peak concentrations usually began in the late afternoon and continued through the night into the next morning. The wind was from the south-southeast or south during each episode. The highest average concentrations occurred between 2 and 4 a.m. at site 510-742, and between midnight and 2 a.m. at site 505-740. The occurrence of typical hydrogen-sulfide-type paint damage during the measurement period indicates that exposure was probably greater than measured; either in concentration or duration.

VISIBILITY

A summary of the visibility observations made from the project office (493-713) is given in Table 42. These results for relative humidity of less than 70 percent show that visibility east across the river into the East St. Louis area was equal to or less than 3 miles during 58.7 percent of the observations during the fall,

Table 42. VISIBILITY OBSERVATIONS FROM SITE NO. 493-713[a]

Time	No. observations	No. observations 70% R.H.[b] or less	East						Southwest					
			<1 mile		<2 miles		<3 miles		<1 mile		<2 miles		<3 miles	
			No.	%[b]	No.	%[c]	No.	%[c]	No.	%[c]	No.	%[c]	No.	%[c]
June Aug. 1963	64	15	0	0.0	3	20.0	6	40.0	0	0.0	0	0.0	3	20.0
Sept. Nov. 1963	58	29	1	3.5	6	20.7	17	58.7	0	0.0	0	0.0	4	13.8
Dec. 1963 Feb. 1964	59	44	4	9.1	9	20.5	23	52.3	3	6.8	5	11.4	13	29.6
March May 1964	48	36	1	2.8	4	11.1	8	22.2	1	2.8	2	5.6	3	8.3
Year	229	124	6	4.8	22	17.8	54	43.5	4	3.2	7	5.6	23	18.6

[a] Times of observations same as for turbidity measurements; see Table 43.

[b] R.H. is relative humidity.

[c] Percent of times when relative humidity was less than 70%.

and 52.3 percent of the time during the winter. The percent of reduced visibility toward the southwest was very much lower, 13.8 in the fall and 29.6 in the winter. These measurements provide additional evidence that the Illinois side of the river had more visibility-reducing pollution than the Missouri side.

Attempts were made to correlate the visibility observations with AISI sampler measurements, sulfur dioxide, and total oxidant measurements from the CAMP station, and high-volume air sampler and atmospheric turbidity measurements made with the Volz Sun Photometer. In each case the correlation was poor to nonexistent. An attempt was made to correlate the low visibility observations with the sulfur dioxide and total oxidant measurements from the CAMP station taken 1 and 2 hours prior to the visibility observations, but such a small number of reduced visibility observations were available after the CAMP station began operating that no correlation could be found. This correlation might be found if more data were available.

One fact that may have resulted in such low correlations is that no landmarks for visibility observations were available between 3 and 10 miles to the east, and none was available beyond 4 miles to the southwest. Also, the observations were made to the nearest mile instead of the nearest half-mile. Using half-mile increments up to 10 miles would give a much better basis for a correlation.

ATMOSPHERIC TURBIDITY

In addition to the visibility observations, measurements of atmospheric turbidity were made with the Volz Sun Photometer at the project office, 493-713. The results are given in Table 43. Attempts were made to correlate these measure-

Table 43. ATMOSPHERIC TURBIDITY OF MEASUREMENTS BY SUN PHOTOMETER FROM SITE NO. 493-713

Date 1963	Time, local	Turbidity	Date 1963	Time, local	Turbidity	Date 1963	Time, local	Turbidity
June 5	8:20	0.225	August 2	8:15	0.105	October 1	9:30	0.073
6	8:15	0.125	5	8:10	0.100	2	9:35	0.108
7	8:20	0.180	6	8:05	0.185	3	9:30	0.072
11	8:15	0.146	8	8:15	0.210	4	9:30	0.096
13	8:15	0.156	9	8:10	0.258	7	10:00	0.113
14	8:25	0.077	13	8:05	0.062	9	9:35	0.138
17	8:20	0.116	14	8:10	0.100	10	9:35	0.146
18	8:10	0.260	16	8:05	0.088	11	9:40	0.117
21	8:10	0.093	23	8:10	0.137	14	9:45	0.170
24	8:20	0.088	26	8:10	0.110	15	9:40	0.290
25	8:10	0.132	27	8:40	0.246	17	9:42	0.375
26	8:15	0.158	28	8:10	0.285	21	9:45	0.160
27	8:05	0.160				22	10:10	0.107
28	8:05	0.112				24	9:50	0.275
						28	9:00	0.070
July 1	8:15	0.216	September 10	9:20	0.150			
2	8:40	0.270	12	9:05	0.092	November 1	9:10	0.062
3	8:05	0.112	19	9:15	0.226	12	9:12	0.070
5	8:10	0.275	20	9:20	0.146	15	9:15	0.125
8	8:15	0.130	23	9:25	0.107			
9	8:15	0.107	24	9:30	0.142	December 2	9:40	0.112
10	8:10	0.093	25	9:20	0.105	6	9:35	0.068
11	8:15	0.125	27	9:28	0.127	18	10:20	0.120
12	8:20	0.107	30	9:30	0.085	23	9:50	0.128
16	8:05	0.103				26	9:55	0.065
19	8:10	0.216				27	9:55	0.093
22	8:20	0.155				30	9:59	0.170
24	8:10	0.170						
25	8:15	0.248						
30	8:10	0.118						
January 1964 13	11:05	0.090	March 6	9:10	0.145	May 1	15:53	0.180
14	9:50	0.095	13	8:50	0.080	4	8:30	0.135
15	10:00	0.076	16	8:47	0.072	5	8:30	0.230
20	9:45	0.065	17	8:50	0.112	5	14:10	0.150
21	9:55	0.068	18	8:40	0.095	14	9:30	0.146
22	9:50	0.080	23	8:30	0.160	15	16:00	0.160
28	9:55	0.230	24	8:30	0.270	19	8:40	0.145
29	9:55	0.075	26	8:26	0.270	20	9:45	0.250
			30	8:30	0.155	21	16:25	0.230
			30	11:25	0.220	22	8:50	0.240
			31	8:10	0.080	25	10:35	0.190
			31	14:36	0.085			
			31	16:10	0.075			
February 4	9:40	0.210	April 1	10:20	0.360			
11	9:45	0.235	2	15:55	0.095			
13	9:34	0.093	6	12:20	0.140			
14	9:32	0.160	6	15:20	0.075			
24	9:17	0.090	7	8:45	0.165			
25	9:12	0.185	9	7:49	0.138			
26	9:22	0.125	10	9:00	0.146			
27	9:07	0.128	13	8:40	0.092			
28	9:06	0.065	13	16:25	0.065			
			14	8:45	0.093			
			15	9:25	0.115			
			16	9:05	0.170			
			17	9:30	0.215			
			22	8:05	0.082			
			27	8:55	0.093			
			30	8:50	0.110			

ments with visibility, AISI sampler, high-volume air sampler, and sulfur dioxide measurements from the CAMP station. These correlations were very low.

Since these low correlations may have resulted from an insufficient amount of data, a more extensive study would be necessary before any final conclusions could be made. If these correlations do exist, it is important, from a program-development point of view, that they be found because the Sun Photometer is an inexpensive and easy-to-use instrument.[56] Another possibility would be to devise an air pollution index similar perhaps to that used by New York City,[22] which includes sulfur dioxide, AISI, and carbon monoxide values, and correlate it with the Sun Photometer. Atmospheric turbidity is a measure of many pollutants, and trying to correlate with one to the exclusion of others may not be possible.

TOTAL OXIDANTS - NETWORK

Total oxidants were measured, using the phenolphthalin method, at nine sites from May through October 1964. The highest value obtained was 0.30 ppm at site 449-719 during October (Table 44). Figure 121, which gives the monthly geometric means and peaks, shows that the geometric means increased from May to July and then decreased from July to October. This is as expected since total oxidants are a result of photochemical reactions that occur to the greatest extent in the warmer months.

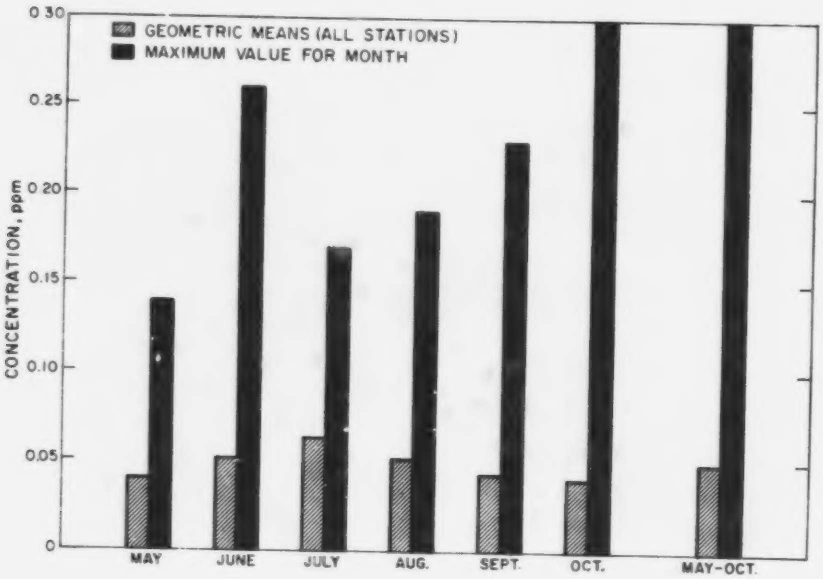


Figure 121. Total oxidants - geometric means and maximums for 1964 months and average for months measured.

Table 44. TOTAL OXIDANTS, ppm

Site coordinates	Minimum	Maximum	N[a]	Arithmetic		Geometric	
				Mean	Standard deviation	Mean	Standard deviation
May 1964							
449-719	0.01	0.10	15	0.046	0.028	0.037	1.983
458-755	0.00	0.11	35	0.045	0.026	0.038	1.877
482-697	0.00	0.13	24	0.037	0.024	0.032	1.757
485-714	0.01	0.08	15	0.040	0.018	0.036	1.727
490-713	0.01	0.07	44	0.036	0.019	0.030	1.885
501-713	0.00	0.14	41	0.073	0.040	0.056	2.374
507-741	0.03	0.10	27	0.051	0.010	0.050	1.183
509-710	0.00	0.12	41	0.056	0.033	0.044	2.260
All	0.00	0.14	242	0.050	0.030	0.040	2.007
June							
449-719	0.03	0.26	59	0.088	0.048	0.078	1.635
458-755	0.00	0.09	66	0.044	0.015	0.041	1.487
482-697	0.01	0.06	24	0.038	0.014	0.035	1.571
485-714	0.01	0.15	66	0.083	0.030	0.076	1.594
490-713	0.00	0.15	65	0.067	0.028	0.060	1.745
501-713	0.01	0.07	36	0.038	0.015	0.034	1.596
507-741	0.01	0.05	61	0.049	0.005	0.048	1.228
509-710	0.01	0.07	32	0.035	0.012	0.033	1.470
All	0.00	0.26	409	0.059	0.033	0.052	1.715
July							
449-719	0.02	0.17	67	0.087	0.031	0.081	1.469
458-755	0.01	0.10	67	0.053	0.019	0.050	1.489
482-697			0				
485-714	0.08	0.16	66	0.118	0.021	0.116	1.210
490-713	0.03	0.15	66	0.091	0.026	0.087	1.383
501-713	0.01	0.06	47	0.039	0.012	0.036	1.485
507-741	0.05	0.10	16	0.056	0.017	0.054	1.267
509-710	0.01	0.07	48	0.036	0.017	0.031	1.710
All	0.01	0.17	377	0.073	0.036	0.063	1.791
August							
449-719	0.01	0.15	59	0.073	0.030	0.066	1.638
458-755	0.01	0.08	63	0.037	0.017	0.032	1.680
482-697	0.01	0.09	57	0.046	0.020	0.041	1.619
485-714	0.05	0.15	63	0.100	0.018	0.099	1.215
490-713	0.02	0.19	58	0.074	0.033	0.067	1.596
501-713	0.01	0.06	37	0.034	0.014	0.030	1.734
507-741	0.05	0.10	39	0.056	0.016	0.054	1.264
509-710	0.01	0.11	37	0.040	0.023	0.034	1.867
All	0.01	0.19	413	0.060	0.032	0.051	1.838
September							
449-719	0.01	0.13	57	0.051	0.024	0.045	1.699
458-755	0.01	0.10	63	0.038	0.018	0.033	1.687
480-725	0.02	0.23	14	0.072	0.060	0.056	2.050
482-697	0.01	0.09	52	0.036	0.017	0.032	1.652
485-714	0.04	0.16	63	0.105	0.027	0.100	1.358
490-713	0.02	0.22	50	0.063	0.038	0.054	1.736
501-713	0.00	0.07	44	0.032	0.016	0.027	1.772
507-741	0.05	0.05	10	0.050	0.000	0.050	1.000
509-710	0.00	0.08	44	0.031	0.018	0.026	1.805
All	0.00	0.23	397	0.053	0.036	0.043	1.958

[a] N = number of samples.

Table 44. (Cont'd) TOTAL OXIDANTS, ppm

Site coordinates	Minimum	Maximum	N[a]	Arithmetic		Geometric	
				Mean	Standard deviation	Mean	Standard deviation
October							
449-719	0.00	0.30	62	0.068	0.051	0.054	2.011
458-755	0.00	0.09	66	0.029	0.016	0.025	1.678
480-725	0.02	0.08	29	0.044	0.020	0.040	1.594
482-697	0.01	0.08	49	0.033	0.015	0.030	1.550
485-714	0.02	0.19	60	0.092	0.030	0.087	1.459
490-713	0.00	0.12	61	0.040	0.026	0.032	2.024
501-713	0.01	0.10	14	0.039	0.027	0.030	2.146
507-741			0				
509-710	0.00	0.10	14	0.040	0.030	0.029	2.258
All	0.00	0.30	355	0.051	0.037	0.040	2.039
May-Oct 1964							
449-719	0.00	0.30	319	0.072	0.040	0.062	1.793
458-755	0.00	0.11	360	0.041	0.020	0.036	1.704
480-725	0.02	0.23	43	0.053	0.039	0.045	1.775
482-697	0.00	0.13	206	0.038	0.019	0.034	1.640
485-714	0.01	0.19	333	0.097	0.030	0.091	1.514
490-713	0.00	0.22	344	0.063	0.034	0.053	1.935
501-713	0.00	0.14	219	0.043	0.026	0.035	1.901
507-741	0.01	0.10	153	0.052	0.011	0.051	1.232
509-710	0.00	0.12	216	0.039	0.024	0.032	1.898
All	0.00	0.30	2193	0.058	0.035	0.048	1.918

[a] N = number of samples.

Figure 122, which gives the frequency distribution for all the sites, indicates that the smog odor level occurred during 4 percent of the measurement times and the eye-irritation level occurred during less than 1 percent of the measurement times. These figures are not alarmingly high, but they do show that St. Louis has experienced photochemical smog, and that with normal growth the potential is present for much greater oxidant concentrations in the future.

When the phenolphthalin method is used, the first sign of smog odor occurs at 0.15 ppm; eye irritation, vegetation damage, and visibility reduction are evident at 0.25 ppm.[23] The State of California adopted 0.15 ppm (a value approximately equal to 0.25 ppm by the phenolphthalin method) for 1 hour by the potassium iodide method as a standard.[19] The State of New York has four ambient air quality objectives for oxidants: 0.05 ppm for 24 hours for rural and residential areas, 0.10 ppm for 24 hours for commercial and industrial areas, 0.15 ppm for 1 hour for all land-use areas, and 0.10 ppm for 4 hours for rural and residential areas.[7] The State of Colorado adopted as its standard[8] 0.10 ppm for 1 hour, and uses the potassium iodide method.

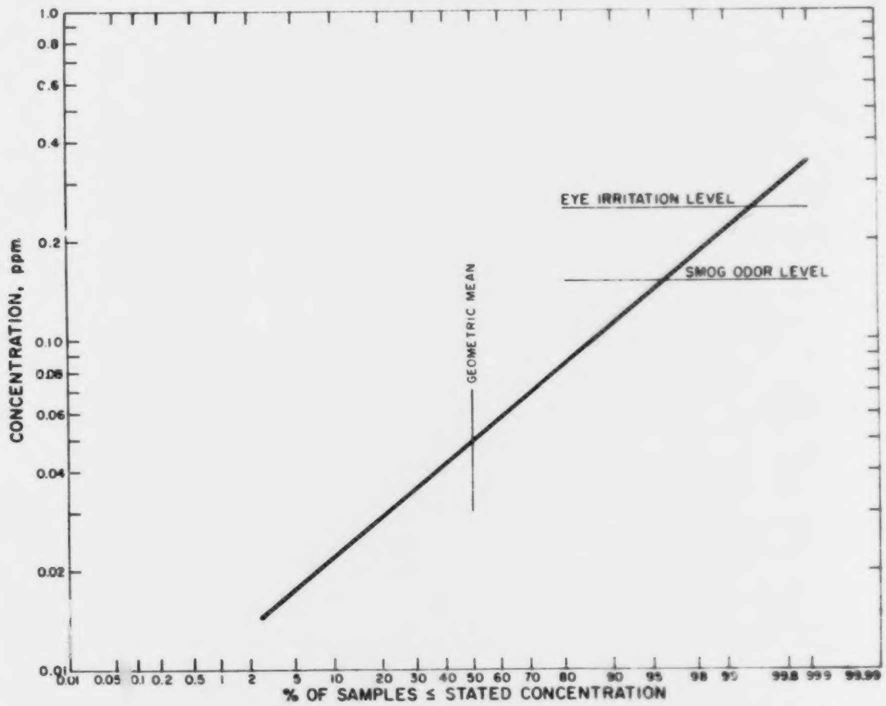


Figure 122. Total oxidants - frequency distribution, all sites (May - Oct 1964).

To show the geographical distribution and variation with time of day and month, data from six stations were used to prepare Table 45 and Figure 123. Since these six stations are in a reasonably straight line from west to east through the center of the metropolitan area, results from them show an oxidant profile. The Mississippi River and grid coordinates are shown for geographic orientation.

May, which is thought to precede the main photochemical smog season, shows levels of about 0.04 ppm across Clayton and St. Louis City, with an increase to about 0.06 ppm in East St. Louis. During the rest of the months the levels were higher in St. Louis and St. Louis County than in East St. Louis. This pattern is quite different from that found for sulfur dioxide and particulate pollutants. Variation during the day showed the morning low, with noon and afternoon values about equal.

Additional discussion of oxidants appears in the CAMP Station Data section of this report and in a report on tobacco plant damage.[70]

AEROALLERGENS

The results of aeroallergen measurements made by the American Academy of Allergy gravity shelter method are given in Tables 46 and 47 . These data show that

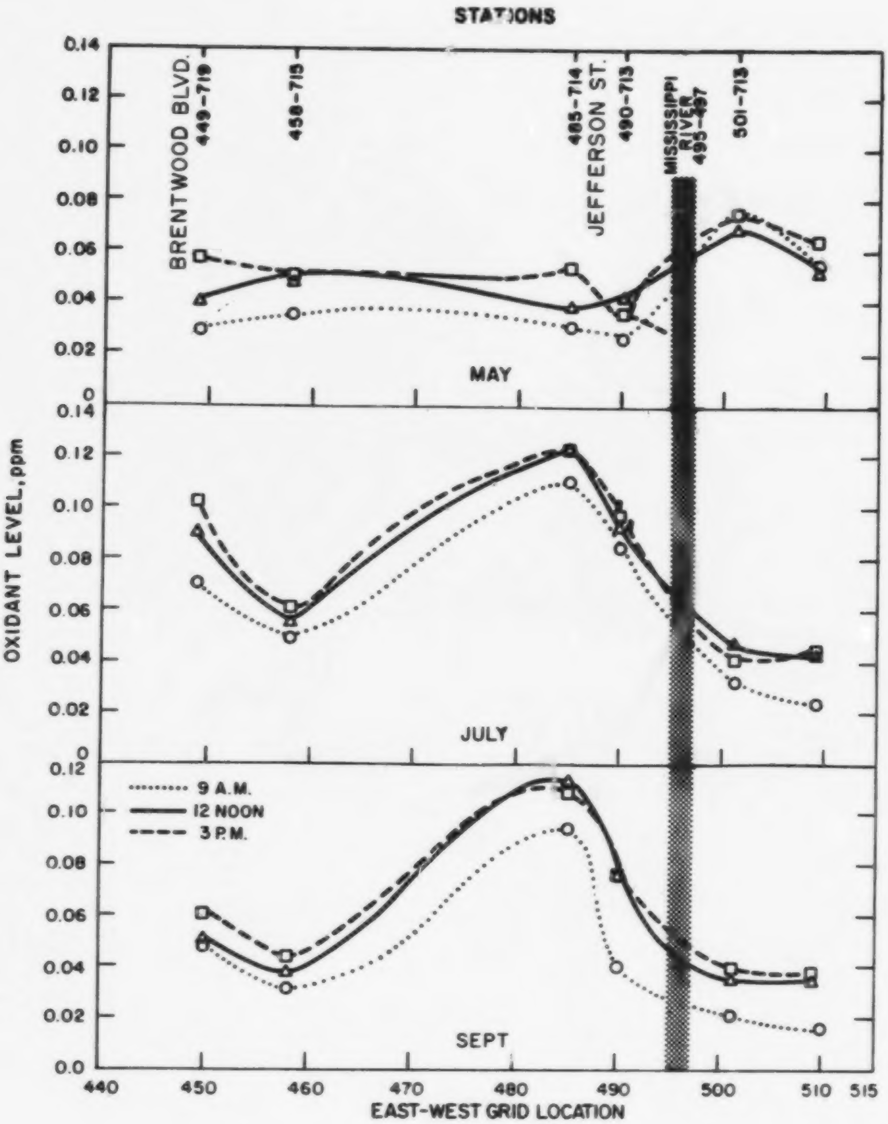


Figure 123. St. Louis Metropolitan Area east-west oxidant profiles.

the pollen season begins in the early spring with tree pollination and continues through the summer with grass pollination (May and June primarily) and into the fall (August and September primarily) with ragweed pollination. The conditions under which pollen is emitted usually include light winds, clear to partly cloudy skies, and at least moderate convection[24] - all of which contribute to vertical movement of the air.

Table 45. TOTAL OXIDANTS BY STATION, MONTH, AND HOUR, 1964

Station	Item	May			June			July			August			September			October		
		09:00	12:00	15:00	09:00	12:00	15:00	09:00	12:00	15:00	09:00	12:00	15:00	09:00	12:00	15:00	09:00	12:00	15:00
449-719 St. Louis County Health Department	No. Observ.	6	5	4	21	20	18	23	21	23	21	18	20	2	18	19	22	22	21
	Avg, ppm	0.028	0.040	0.057	0.069	0.085	0.099	0.070	0.090	0.103	0.056	0.082	0.083	0.049	0.050	0.061	0.035	0.090	0.085
	Min, ppm	0.010	0.030	0.040	0.030	0.050	0.030	0.020	0.040	0.050	0.020	0.010	0.030	0.020	0.020	0.010	0.000	0.030	0.030
	Max, ppm	0.050	0.100	0.100	0.260	0.210	0.260	0.150	0.140	0.170	0.110	0.150	0.110	0.100	0.080	0.130	0.060	0.300	0.190
458-715 St. Marys Hospital St. Louis	No. Observ.	11	12	12	22	22	22	23	23	21	21	21	21	21	21	21	22	22	22
	Avg, ppm	0.035	0.049	0.051	0.035	0.048	0.050	0.049	0.055	0.059	0.032	0.039	0.038	0.031	0.038	0.045	0.023	0.030	0.035
	Min, ppm	0.010	0.010	0.000	0.010	0.030	0.010	0.020	0.030	0.010	0.020	0.010	0.010	0.010	0.010	0.010	0.010	0.000	0.010
	Max, ppm	0.060	0.110	0.100	0.050	0.070	0.100	0.090	0.100	0.100	0.070	0.070	0.070	0.070	0.090	0.100	0.040	0.080	0.090
482-697 Alexian Brothers Hospital	No. Observ.	7	8	9	8	7	9				20	18	19	20	17	15	19	17	16
	Avg, ppm	0.026	0.041	0.043	0.025	0.044	0.047				0.028	0.056	0.056	0.024	0.046	0.043	0.024	0.042	0.038
	Min, ppm	0.000	0.020	0.030	0.010	0.030	0.030		ND[a]		0.010	0.030	0.030	0.010	0.020	0.020	0.010	0.020	0.020
	Max, ppm	0.040	0.130	0.080	0.040	0.060	0.060				0.040	0.090	0.090	0.050	0.070	0.090	0.050	0.080	0.070
485-714 St. Louis Testing Laboratory	No. Observ.	5	5	5	22	22	22	22	22	22	21	21	21	21	21	27	20	20	20
	Avg, ppm	0.030	0.038	0.054	0.067	0.095	0.090	0.110	0.123	0.123	0.090	0.107	0.107	0.094	0.113	0.109	0.084	0.098	0.098
	Min, ppm	0.010	0.020	0.040	0.010	0.040	0.060	0.080	0.080	0.080	0.050	0.080	0.060	0.040	0.050	0.040	0.020	0.050	0.040
	Max, ppm	0.050	0.060	0.080	0.150	0.140	0.150	0.150	0.150	0.160	0.110	0.150	0.140	0.160	0.160	0.140	0.130	0.140	0.190
490-713 St. Louis City Municipal Courts	No. Observ.	14	15	15	21	22	22	22	22	22	19	20	19	17	16	17	21	20	20
	Avg, ppm	0.027	0.042	0.039	0.057	0.080	0.067	0.085	0.093	0.096	0.059	0.083	0.082	0.042	0.075	0.074	0.029	0.049	0.044
	Min, ppm	0.010	0.010	0.010	0.010	0.000	0.000	0.070	0.050	0.030	0.020	0.040	0.020	0.020	0.040	0.020	0.000	0.010	0.000
	Max, ppm	0.050	0.070	0.070	0.100	0.150	0.110	0.140	0.120	0.150	0.100	0.190	0.150	0.090	0.220	0.180	0.050	0.120	0.100
501-713 East St. Louis City Hall	No. Observ.	15	15	11	14	11	11	17	16	13	14	15	8	14	15	15	6	6	2
	Avg, ppm	0.075	0.069	0.075	0.034	0.038	0.048	0.031	0.046	0.040	0.026	0.039	0.040	0.021	0.035	0.039	0.017	0.045	0.090
	Min, ppm	0.010	0.000	0.000	0.010	0.020	0.030	0.010	0.040	0.020	0.010	0.010	0.020	0.000	0.010	0.010	DNS[b]	DNS	DNS
	Max, ppm	0.140	0.130	0.120	0.070	0.070	0.060	0.060	0.060	0.060	0.050	0.060	0.060	0.040	0.070	0.070			
509-710 East Side Health District	No. Observ.	15	14	12	12	9	11	18	16	14	14	14	9	14	15	15	6	6	2
	Avg, ppm	0.053	0.052	0.064	0.029	0.040	0.038	0.023	0.043	0.044	0.021	0.055	0.049	0.016	0.035	0.039	0.013	0.048	0.090
	Min, ppm	0.000	0.000	0.000	0.010	0.020	0.020	0.010	0.020	0.020	0.000	0.020	0.030	0.030	0.020	0.000	DNS	DNS	DNS
	Max, ppm	0.120	0.120	0.120	0.040	0.070	0.060	0.050	0.070	0.070	0.040	0.110			0.020	0.080			
480-725 Homer Phillips Hospital	No. Observ.													4	5 DNS	5	9	10	10
	Avg, ppm													0.030	0.086	0.094	0.037	0.045	0.052
	Min, ppm		ND			ND			ND			ND		0.020	0.030	0.050	0.020	0.020	0.020
	Max, ppm													0.050	0.250	0.180	0.070	0.080	0.080
507-740 Granite City Fire Station	No. Observ.	10	8 DNS	9	20	20 DNS	21	5	6 DNS	5	12 DNS	13 DNS	14	2	2 DNS	6			
	Avg, ppm	0.048	0.050	0.056	0.050	0.050	0.050	0.050	0.059	0.050	0.054	0.058	0.057	0.050	0.050	0.050			
	Min, ppm	0.030	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050		ND	
	Max, ppm	0.050	0.050	0.100	0.050	0.050	0.050	0.050	0.100	0.050	0.100	0.100	0.100	0.050	0.050	0.050			

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[a] ND indicates no data.

[b] DNS indicates data not significant.

Table 46. POLLEN AND MOLD COUNTS FOR 1963 AT SITE COORDINATES 481-718 BY AMERICAN ACADEMY OF ALLERGY GRAVITY POLLEN SAMPLER[a]

Month[b]	Elm Hackberry	Poplar Cottonwood	Maple	Oak	Sycamore	Hickory Walnut	Grass	Plantain	Goosefoot	Ragweed	Molds
	Count[c], grains/yd^3										
March											
Min	28	0	0	0	0	0	0	0	0	0	0
Max	450	216	26	82	36	16	0	0	0	0	40
Avg	134.9	30.5	4.9	17.5	4.2	2.5	0	0	0	0	9.5
April											
Min	0	0	0	6	0	0	0	0	0	0	0
Max	16	48	7	1300	400	112	6	0	0	0	72
Avg	1.7	7.5	0.4	254.3	92.1	13.4	0.2	0	0	0	15.1
May											
Min	0	0	0	0	0	0	0	0	0	0	0
Max	2	2	0	36	8	62	14	0	1	2	87
Avg	0.2	0.0	0	6.2	0.3	12.3	5.0	0	0.0	0.2	23.2
June											
Min	0	0	0	0	0	0	0	0	0	0	0
Max	0	0	0	0	0	6	16	6	0	4	153
Avg	0	0	0	0	0	0.3	7.6	1.2	0	0.2	50.1
July											
Min	0	0	0	0	0	0	0	0	0	0	0
Max	0	0	0	0	0	0	8	6	4	8	230
Avg	0	0	0	0	0	0	2.8	1.9	0.7	1.0	52.9
August											
Min	0	0	0	0	0	0	0	0	0	0	0
Max	0	0	0	0	0	0	0	24	152	402	276
Avg	0	0	0	0	0	0	0	1.6	21.9	86.4	57.6
September											
Min	0	0	0	0	0	0	0	0	0	12	4
Max	0	0	0	0	0	0	0	0	88	364	320
Avg	0	0	0	0	0	0	0	0	31.4	112.7	75.5

[a] Data supplied by Dr. French K. Hansel, Allergist.

[b] Readings were taken every day except Sundays and holidays

[c] These figures divided by 3.6 would be comparable to grains per square centimeter values reported by the American Academy of Allergy gravity pollen sampler.

The large differences between the minimum and maximum values for **each** month are due to the sampling method as well as changes in wind speed, direction, and atmospheric turbulence and differences in release of pollen. Although pollen counts have not been precisely correlated with human reaction, it is known that human response to allergens varies considerably, both in respect to allergen types and quantities. All of the aeroallergens listed in Tables 46 and 47 are important in the St. Louis area, and most of them reach very high concentrations during their peak seasons.

The results from the samples collected by the rotoslide sampler are not included. The slides were stored in regular microscope slide boxes with no provisions for protecting the edge of the slide, and all of the samples were damaged before analysis. It should be emphasized here that regular microscope slide boxes are constructed to protect the flat surfaces of the slides and not the edges where the pollen samples are collected with the rotoslide sampler. The boxes must be modified somewhat if they are to be used for this purpose.

CAMP STATION DATA

Table 48 presents the results from the six CAMP stations from March through

Table 47. POLLEN AND MOLD COUNTS FOR 1964 AT SITE NO. 481-718 BY AMERICAN ACADEMY OF ALLERGY GRAVITY POLLEN SAMPLER[a]

Month[b]	Elm Hackberry	Poplar Cottonwood	Maple	Oak	Sycamore	Hickory Walnut	Grass	Plantain	Goosefoot	Ragweed	Molds
	Count,[c] grain/yd^3										
March											
Min	6	0	2	0	0	0	0	0	0	0	0
Max	112	0	4	0	0	0	0	0	0	0	10
Avg	40.4	0	1.1	0	0	0	0	0	0	0	3.0
April											
Min	0	0	0	0	0	0	0	0	0	0	0
Max	70	48	12	830	850	18	0	0	0	0	0
Avg	12.8	10.0	2.1	117.2	78.6	3.3	0	0	0	0	0
May											
Min	0	0	0	0	0	0	0	0	0	0	0
Max	10	20	0	390	54	150	18	0	0	0	0
Avg	0.9	1.4	0	78.2	9.4	39.3	4.6	0	0	0	0
June											
Min	0	0	0	0	0	0	0	0	0	0	0
Max	0	0	0	0	36	4	32	12	6	2	164
Avg	0	0	0	0	4.4	0.2	4.3	2.8	0.5	0.2	30.6
July											
Min	0	0	0	0	0	0	0	0	0	0	6
Max	0	0	0	0	0	0	6	8	5	6	109
Avg	0	0	0	0	0	0	0.8	1.3	0.9	0.8	28.8
August											
Min	0	0	0	0	0	0	0	0	0	0	0
Max	0	0	0	0	0	0	0	0	34	230	98
Avg	0	0	0	0	0	0	0	0	11.2	47.8	33.3
September											
Min	0	0	0	0	0	0	0	0	2	0	6
Max	0	0	0	0	0	0	0	0	56	374	202
Avg	0	0	0	0	0	0	0	0	30.7	144.3	71.8

[a] Data supplied by Dr. French K. Hansel, Allergist.

[b] Readings were taken every day except Sundays and holidays.

[c] These figures divided by 3.6 would be comparable to pollen grains per square centimeter of slide area values using the same sampler.

December 1964 and 1964 yearly means for all cities except St. Louis. Sampling was done during 10 months only in St. Louis. CAMP station data not available at the time this report was prepared may be obtained from the Public Health Service to assist with further interpretation of these data.

The frequency distributions of the St. Louis 5-minute-sample data from March 1964 to February 1965 are presented in Figures 124 and 125. The median sulfur dioxide concentration was 0.04 ppm with 17 percent of the measurements above 0.10 ppm. Oxidant levels (potassium iodide method) exceeded 0.10 ppm slightly over 1 percent of the time. The seasonal and yearly diurnal variations are presented in Table 49. Figure 126 shows the yearly diurnal variations of the CAMP station measurements. The curves for carbon monoxide, nitrogen oxide, and hydrocarbons show peaks between 6 and 8 a.m. and 4 and 6 p.m., times when traffic is heaviest. The sulfur dioxide curve shows peaks at 8 to 9 a.m. and 8 to 10 p.m. The oxidant curve peaks around 1 to 2 p.m. when the sunlight is the most intense.

Figure 127 dramatically illustrates the influence of meteorological conditions on pollution levels. The Public Health Service Air Pollution Potential Forecast program issued an air pollution alert for October 15 and 16, 1964, for a large

Table 48. SUMMARY OF DATA FROM CAMP CITIES FROM MARCH THROUGH DECEMBER 1964

City	Month	Concentration, ppm											
		Carbon monoxide		Nitric oxide		Nitrogen dioxide		Sulfur dioxide		Total hydrocarbon		Total oxidants	
		Avg	5-min max	Avg	5-min max	Avg	5-min max	Avg	5-min max	Avg	5-min max	Avg	5-min max
Chicago	Mar	10	36	0.10	0.32	0.04	0.12	0.20	1.31	3	8	0.05	0.17
	Apr	11	40	0.08	0.31	0.04	0.09	0.13	1.22	3	10	0.06	0.19
	May	13	44	0.06	0.31	0.04	0.17	0.09	0.81	4	11	0.06	0.17
	June	12	38	0.07	0.36	0.07	0.19	0.06	0.87	4	12	0.05	0.15
	July	17	60	0.06	0.28	0.07	0.19	0.11	1.24	-	16	0.04	0.14
	Aug	15	52	0.08	0.40	0.05	0.79	0.06	1.05	4	20	0.02	0.09
	Sept	-	49	--	0.53	--	0.11	--	1.07	-	-	--	0.07
	Oct	12	64	0.16	0.97	0.06	0.39	0.16	1.23	2	12	--	0.06
	Nov	14	53	0.14	0.80	0.04	0.11	0.20	1.35	3	11	0.02	0.15
	Dec	11	49	0.13	0.48	0.03	0.08	0.27	1.04	3	9	0.01	0.10
	Year[a]	12	64	0.10	0.97	0.05	0.79	0.18	1.62	3	20	0.03	0.15
Cincinnati	Mar	-	-	0.02	0.20	0.02	0.06	0.03	0.41	3	12	0.01	0.04
	Apr	6	13	0.02	0.33	0.02	0.06	0.03	0.67	3	14	0.02	0.07
	May	9	23	0.02	0.21	0.03	0.14	0.02	0.84	3	9	0.03	0.08
	June	11	24	0.02	0.22	0.03	0.20	0.02	0.62	3	8	0.03	0.11
	July	-	21	0.03	0.22	0.04	0.16	0.03	0.61	3	8	0.06	0.38
	Aug	-	15	0.03	0.32	0.04	0.25	0.04	0.81	3	8	0.04	0.16
	Sept	3	22	0.03	0.33	0.04	0.25	0.04	0.76	3	9	0.04	0.16
	Oct	4	26	0.07	0.47	0.05	0.20	0.05	0.61	4	9	0.04	0.13
	Nov	5	25	0.10	0.68	0.04	0.30	0.06	0.88	4	18	0.03	0.13
	Dec	4	49	0.05	0.54	0.03	0.07	0.06	0.87	3	14	0.02	0.13
	Year[a]	6	49	0.04	0.68	0.03	0.30	0.04	0.88	3	20	0.03	0.32
Philadelphia	Mar	5	21	0.04	0.53	0.04	0.13	0.09	0.72	2	10	0.02	0.14
	Apr	9	39	0.03	0.29	0.04	0.12	0.10	0.63	2	8	0.02	0.10
	May	7	29	0.03	0.68	0.05	0.29	0.09	0.72	2	14	0.04	0.15
	June	5	14	0.02	0.31	0.04	0.15	--	0.69	2	8	0.05	0.24
	July	4	15	0.02	0.16	0.04	0.19	--	0.67	2	6	0.04	0.18
	Aug	5	18	0.02	0.31	0.04	0.16	0.07	0.55	2	9	0.04	0.20
	Sept	6	24	0.03	0.46	0.04	0.37	--	0.58	2	17	0.03	0.25
	Oct	8	41	0.07	0.59	--	0.25	0.03	0.44	3	15	0.02	0.13
	Nov	13	43	0.09	0.87	--	0.06	0.03	0.65	2	11	0.01	0.19
	Dec	10	46	0.06	0.63	0.03	0.12	--	--	2	8	0.02	0.24
	Year[a]	7	46	0.04	1.35	0.04	0.37	0.08	1.00	2	17	0.02	0.25

Table 48. (Cont'd) SUMMARY OF DATA FROM CAMP CITIES
FROM MARCH THROUGH DECEMBER 1964

City	Month	Concentration, ppm											
		Carbon monoxide		Nitric oxide		Nitrogen dioxide		Sulfur dioxide		Total hydrocarbon		Total oxidants	
		Avg	5-min max	Avg	5-min max	Avg	5-min max	Avg	5-min max	Avg	5-min max	Avg	5-min max
Washington	Mar	5	20	0.02	0.20	0.04	0.14	--	0.29	3	6	0.03	0.16
	Apr	6	21	0.02	0.29	0.03	0.09	0.04	0.25	2	7	0.03	0.11
	May	6	21	0.02	0.34	0.04	0.24	0.04	0.26	3	12	0.05	0.14
	June	6	25	0.02	0.41	0.04	0.20	0.03	0.29	3	8	0.05	0.19
	July	-	-	0.01	0.15	0.03	0.15	0.02	0.17	3	8	0.03	0.15
	Aug	6	19	0.01	0.23	0.03	0.15	0.02	0.20	3	12	0.03	0.14
	Sept	5	21	0.02	0.31	0.03	0.16	0.03	0.20	3	11	0.03	0.19
	Oct	6	29	0.06	0.69	0.04	0.16	0.07	0.87	3	15	0.03	0.18
	Nov	-	14	0.07	0.53	0.04	0.23	0.09	0.73	4	16	0.03	0.17
	Dec	6	37	0.04	0.60	0.03	0.07	0.08	0.38	3	12	--	0.24
	Year[a]	6	37	0.03	0.90	0.04	0.24	0.05	0.73	3	17	0.03	0.24
San Francisco	Mar	6	19	0.08	0.54	0.07	0.46	0.01	0.13	4	15	0.02	0.10
	Apr	5	15	0.07	0.72	0.06	0.39	0.02	0.06	3	12	0.02	0.12
	May	3	14	0.05	0.25	0.05	0.26	0.01	0.06	3	8	--	0.08
	June	4	13	0.05	0.25	0.05	0.27	0.01	0.04	2	9	--	0.16
	July	3	17	0.07	0.74	0.04	0.46	0.01	0.07	2	8	0.02	0.17
	Aug	4	22	0.11	0.80	0.04	0.43	0.02	0.11	2	9	0.01	0.07
	Sept	6	25	0.12	0.63	0.07	0.52	0.03	0.26	3	16	0.02	0.22
	Oct	6	31	0.13	0.81	0.08	0.33	0.03	0.19	3	12	0.02	0.16
	Nov	6	40	0.10	0.65	0.05	0.18	0.02	0.17	-	7	0.03	0.10
	Dec	6	33	0.12	0.85	0.05	0.20	0.01	0.15	-	2	0.03	0.11
	Year[a]	5	40	0.09	0.85	0.06	0.52	0.02	0.26	3	16	0.02	0.22
St. Louis[a]	Mar	6	28	0.03	0.41	0.03	0.25	0.09	1.06	-	-	0.02	0.08
	Apr	7	34	0.04	0.30	0.04	0.09	0.06	0.94	4	11	0.03	0.10
	May	7	33	0.03	0.41	0.04	0.15	0.04	0.65	3	9	0.05	0.23
	June	8	32	0.03	0.26	0.04	0.12	0.03	0.58	3	8	0.03	0.14
	July	9	29	0.02	0.18	0.03	0.11	0.06	1.01	2	9	0.04	0.85
	Aug	5	25	0.02	0.16	0.03	0.13	0.05	0.96	3	12	0.04	0.17
	Sept	5	42	0.03	0.40	0.04	0.24	0.07	0.01	4	12	0.02	0.50
	Oct	5	45	0.04	0.84	0.03	0.31	0.08	0.99	4	20	0.03	0.32
	Nov	6	38	0.05	0.32	0.03	0.09	0.08	1.16	3	13	0.03	0.13
	Dec	5	41	0.06	0.37	0.02	0.06	0.09	0.97	3	12	0.02	0.31
	Year[a]	6	45	0.04	0.84	0.03	0.31	0.06	1.16	3	20	0.03	0.85

[a] St. Louis yearly average is based on data from 10 months. Data for other cities are based on 12 months.

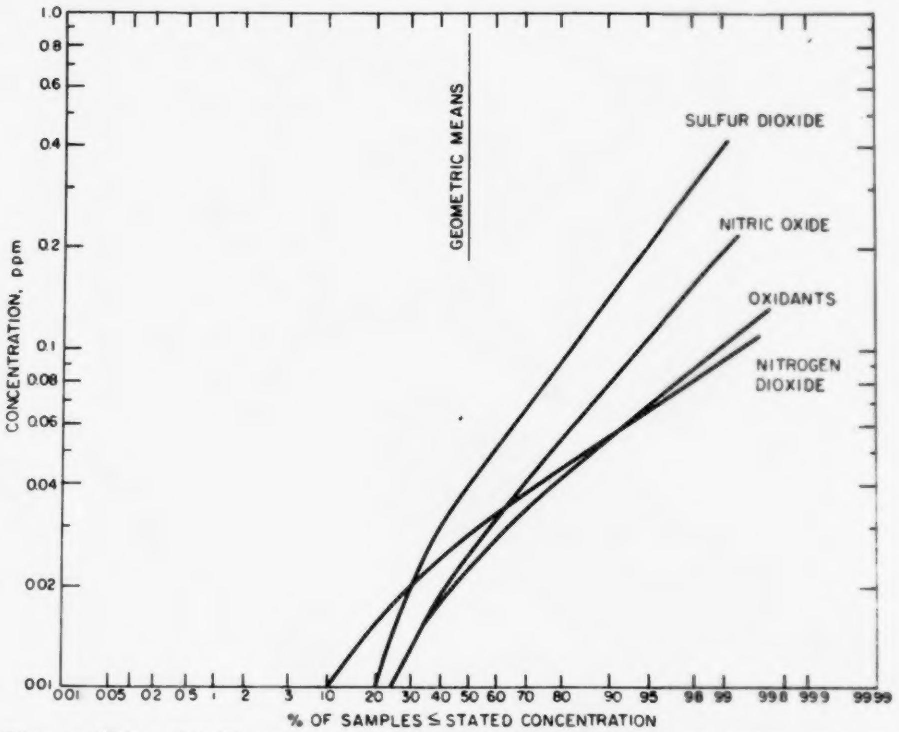

Figure 124. CAMP station frequency distribution (March 1964 - Feb 1965).

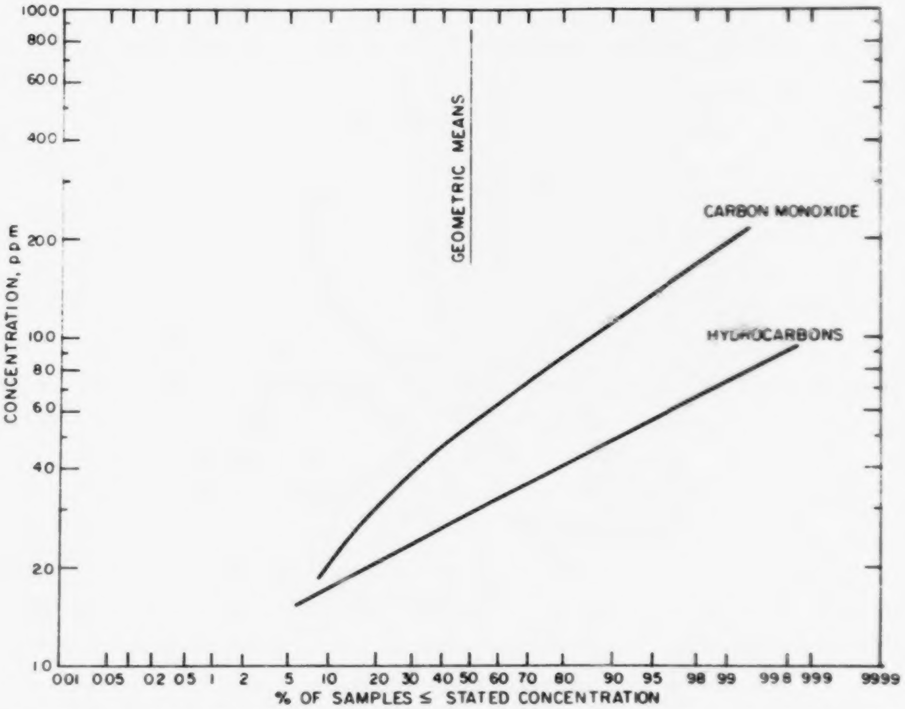

Figure 125. CAMP station frequency distribution (March - Feb 1965).

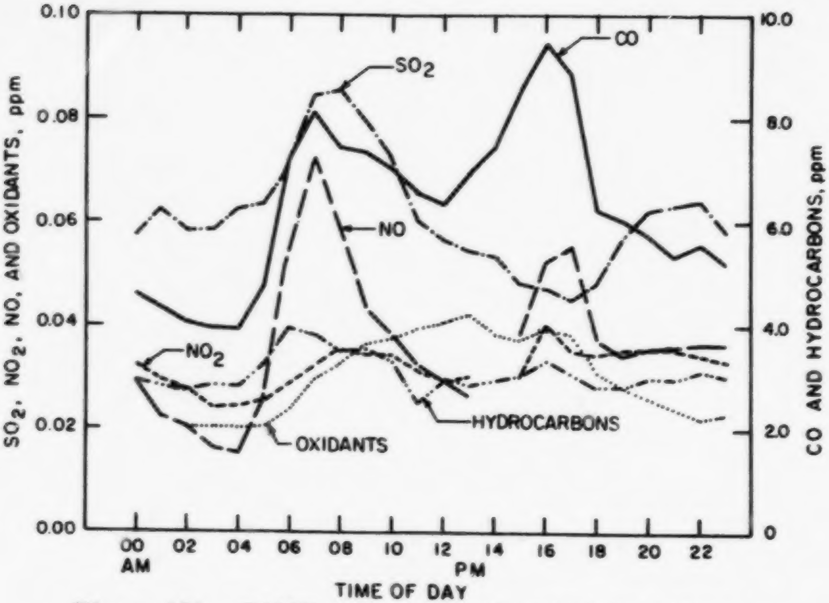

Figure 126. CAMP station diurnal variations (March - Feb 1965).

midwest area that included St. Louis. Hourly pollutant concentrations at the St. Louis CAMP station for the period October 13 through 18, 1964, are presented in Figure 127. The peak concentrations for carbon monoxide, hydrocarbons, nitrogen oxide, and nitrogen dioxide obtained on October 16 were the yearly maximum concentrations for these pollutants. Significantly, the concentrations reached their peaks during the early morning hours (7 to 9 a.m.) and then decreased as the sun warmed the earth and created turbulence in the atmosphere. Another important point is the manner in which the nitrogen dioxide peak lagged the nitric oxide, carbon monoxide, and hydrocarbon peaks by about 2 hours.

One of the most unusual peaks recorded at the St. Louis CAMP station was 0.85 ppm for total oxidants on July 1, 1964, at 8:40 p.m. This was the highest total oxidant reading ever recorded by any CAMP station to that time. The sulfur dioxide instrument also showed a sharp increase during this period, but the other instrument readings remained constant. The pollutant causing the increase could not, based on present knowledge, have been photochemical smog since the rise was detected long after the major flow of traffic had subsided and the sun had set. The wind readings from 7 to 9 p.m. that evening at the KMOX tower fluctuated from the south to southeast. The wind speeds were very low.

Another similar incident occurred on September 14, 1964, at 7 p.m. when a total oxidant value of 0.50 ppm was recorded. The sulfur dioxide instrument also showed a slight increase at that time but the other instrument readings remained constant. Again, the wind at the KMOX-TV tower was from the south to southeast at

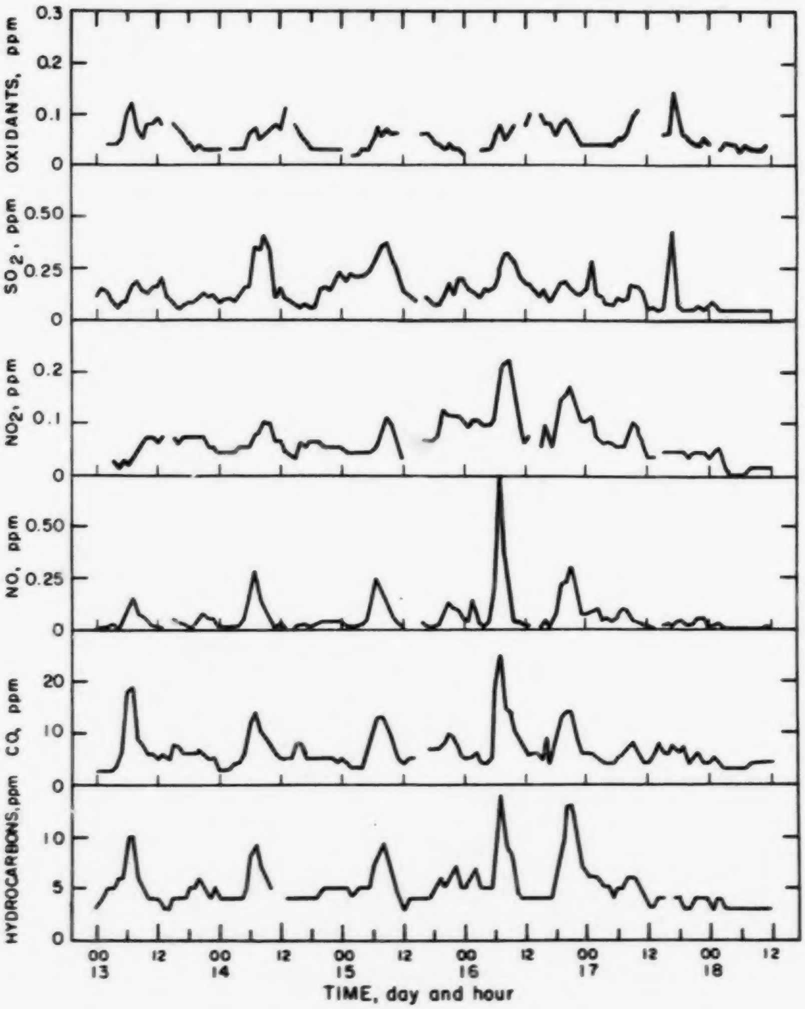

Figure 127. Data from CAMP station (Oct 13-18, 1964).

low speeds. Although the actual source of the material causing these unusual readings is not known, the wind directions during the incidents clearly indicate that this pollutant comes from the south to southeast direction where large industrial areas are located. The material causing these incidents could be any of several compounds since chlorine, hydrogen peroxide, organic peroxide, and other oxidizing substances will react to liberate iodine, which is used to determine the total oxidants by this method.

An attempt was made to find a quantitative relationship between hydrocarbons and oxidants. If such a relationship could be found, a means would be available for rational determination of needed reduction of hydrocarbon emissions. The CAMP

Table 49. DIURNAL VARIATIONS IN HYDROCARBONS AND OXIDANTS MEASURED AT ST. LOUIS CAMP STATION IN 1964 (ppm)

Season, year	Pollutant	Time of day																							
		0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-21	21-22	22-23	23-24
Spring	Carbon monoxide	5.3	5.3	5.0	4.7	4.7	5.3	7.0	8.0	7.3	7.3	7.3	7.0	7.0	7.0	7.7	8.3	9.3	8.3	6.7	6.7	6.3	6.0	6.3	5.7
Summer		6.3	6.0	5.7	6.0	6.0	7.7	11.4	9.7	8.7	9.7	9.0	7.5	7.5	9.0	10.0	11.7	10.7	8.3	8.3	8.0	7.7	7.3	7.0	6.7
Fall		3.7	3.0	3.0	3.0	3.0	3.7	6.7	7.7	7.3	6.3	5.7	5.3	5.3	5.3	5.7	7.0	8.0	7.0	5.3	5.0	5.0	4.3	4.7	4.3
Winter		3.0	3.0	2.7	2.0	2.0	2.3	3.7	7.0	6.3	6.0	6.0	6.3	5.7	6.3	6.3	7.0	9.7	8.3	9.7	4.3	4.0	3.7	4.3	4.3
Year		4.6	4.3	4.0	3.9	3.9	4.7	7.2	8.1	7.4	7.3	7.0	6.5	6.3	6.9	7.4	8.5	9.4	8.8	6.2	6.0	5.7	5.3	5.5	5.2
Spring[a]	Nitrogen oxide	0.025	0.020	0.020	0.015	0.015	0.030	0.065	0.080	0.060	0.040	0.030	0.025	0.025	0.025	--	0.040	0.045	0.040	0.025	0.030	0.030	0.025	0.035	0.030
Summer		0.023	0.017	0.013	0.013	0.013	0.030	0.063	0.063	0.033	0.027	0.023	0.017	0.013	0.013	--	0.030	0.030	0.013	0.013	0.013	0.020	0.023	0.027	0.027
Fall		0.033	0.027	0.023	0.020	0.017	0.027	0.067	0.100	0.080	0.057	0.040	0.030	0.027	0.020	--	0.037	0.053	0.057	0.040	0.040	0.040	0.043	0.040	0.043
Winter		0.023	0.023	0.023	0.017	0.013	0.013	0.023	0.047	0.060	0.047	0.057	0.053	0.050	0.047	--	0.047	0.077	0.110	0.067	0.050	0.047	0.043	0.043	0.043
Year		0.029	0.022	0.020	0.016	0.015	0.025	0.054	0.072	0.088	0.043	0.038	0.032	0.029	0.026	--	0.038	0.052	0.055	0.037	0.034	0.035	0.035	0.036	0.036
Spring	Nitrogen dioxide	0.045	0.035	0.035	0.035	0.035	0.035	0.040	0.045	0.045	0.045	0.040	0.032	0.035	0.035	--	--	0.045	0.045	0.040	0.045	0.045	0.045	0.045	0.045
Summer		0.033	0.033	0.030	0.027	0.027	0.033	0.037	0.040	0.043	0.037	0.037	0.033	0.030	0.030	--	0.030	0.047	0.033	0.033	0.033	0.037	0.037	0.037	0.037
Fall		0.033	0.030	0.027	0.023	0.027	0.027	0.027	0.030	0.037	0.040	0.037	0.033	0.030	0.030	--	0.035	0.040	0.037	0.033	0.037	0.037	0.037	0.037	0.033
Winter		0.020	0.020	0.020	0.013	0.010	0.010	0.013	0.017	0.017	0.017	0.023	0.023	0.023	0.027	--	0.027	0.030	0.030	0.030	0.027	0.023	0.023	0.020	0.020
Year		0.032	0.029	0.027	0.024	0.024	0.025	0.028	0.032	0.035	0.034	0.034	0.031	0.029	0.030	--	0.030	0.040	0.035	0.034	0.035	0.035	0.035	0.034	0.033
Spring	Sulfur dioxide	0.063	0.060	0.060	0.060	0.077	0.077	0.080	0.090	0.093	0.083	0.063	0.043	0.047	0.047	0.067	0.050	0.047	0.043	0.037	0.057	0.063	0.060	0.070	0.053
Summer		0.040	0.047	0.050	0.037	0.040	0.037	0.053	0.067	0.060	0.050	0.043	0.040	0.040	0.040	0.037	0.040	0.033	0.027	0.030	0.033	0.047	0.053	0.053	0.043
Fall		0.073	0.083	0.073	0.073	0.070	0.073	0.090	0.103	0.113	0.110	0.103	0.083	0.070	0.067	0.060	0.053	0.057	0.060	0.067	0.073	0.067	0.073	0.073	0.077
Winter		0.053	0.057	0.050	0.063	0.060	0.063	0.067	0.077	0.073	0 073	0.077	0.073	0.067	0.063	0.060	0.050	0.053	0.050	0.060	0.063	0.070	0.067	0.060	0.087
Year		0.057	0.062	0.058	0.058	0.062	0.063	0.070	0.084	0.085	0.079	0.072	0.060	0.056	0.054	0.053	0.048	0.047	0.045	0.048	0.057	0.062	0.063	0.064	0.058
Spring[a]	Total hydro-carbons	3.0	2.5	2.5	3.0	3.5	3.5	4.0	4.0	3.5	3.5	3.0	3.0	3.5	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.5	3.5
Summer		2.3	2.3	2.3	2.3	2.0	2.7	3.7	3.0	2.7	2.7	2.7	2.3	2.3	2.3	2.7	2.7	2.7	2.0	2.0	2.0	2.3	2.3	2.7	2.3
Fall		3.3	3.3	3.0	3.0	3.0	3.7	4.3	4.3	4.0	4.0	3.7	3.0	3.0	3.0	3.0	3.3	3.7	3.7	3.3	3.3	3.3	3.3	3.3	3.3
Winter[b]		3.0	3.0	3.0	3.0	3.0	3.0	3.0	4.0	4.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	3.0
Year		2.9	2.8	2.7	2.8	2.8	3.2	3.9	3.8	3.5	3.5	3.3	2.5	2.9	2.8	2.9	3.0	3.3	3.0	2.8	2.8	2.9	2.9	3.1	3.0
Spring	Total oxidants	0.027	--	0.027	0.027	0.027	0.030	0.030	0.033	0.037	0.040	0.040	0.043	0.043	0.043	0.047	0.043	0.043	0.040	0.037	0.030	0.030	0.030	0.027	0.027
Summer		0.020	--	0.017	0.017	0.017	0.013	0.020	0.027	0.037	0.047	0.050	0.057	0.057	0.057	0.040	0.050	0.050	0.050	0.040	0.033	0.030	0.023	0.017	0.017
Fall		0.023	--	0.020	0.023	0.017	0.023	0.023	0.030	0.030	0.033	0.037	0.037	0.040	0.043	--	0.033	0.033	0.033	0.027	0.027	0.023	0.023	0.023	0.023
Winter		0.017	--	0.017	0.013	0.020	0.017	0.017	0.027	0.023	0.023	0.020	0.020	0.020	0.023	0.025	0.023	0.030	0.027	0.020	0.020	0.020	0.020	0.020	0.023
Year		0.022	--	0.020	0.020	0.020	0.020	0.023	0.029	0.032	0.036	0.037	0.039	0.040	0.042	0.038	0.037	0.039	0.038	0.031	0.028	0.026	0.024	0.022	0.023

[a] March missing.

[b] January and February missing.

station data were used, since the CAMP station was the only place where hydrocarbons were measured and where sufficient oxidant and other data were gathered to allow comparison. The attempt failed, but the following valuable observations were made.

During July and August 1964, on days with little cloud cover, no rain, and oxidant levels of 0.05 ppm or higher, hydrocarbons measured at 8 a.m. were compared with the maximum oxidant level measured between 10 a.m. and 4 p.m. (Figure 128). The maximum nitrogen dioxide values between 7 and 11 a.m. were also compared to these maximum oxidant levels (Figure 129). Data were 1-hour average concentrations. Both Figures 128 and 129 show the same 5 high-oxidant-level days separated in what appears to be a separate function from the rest of the data. Hourly wind observations between 10 a.m. and 4 p.m. were matched with hourly oxidant levels for these 5 high-oxidant days as well as for the rest of the July and August days under investigation

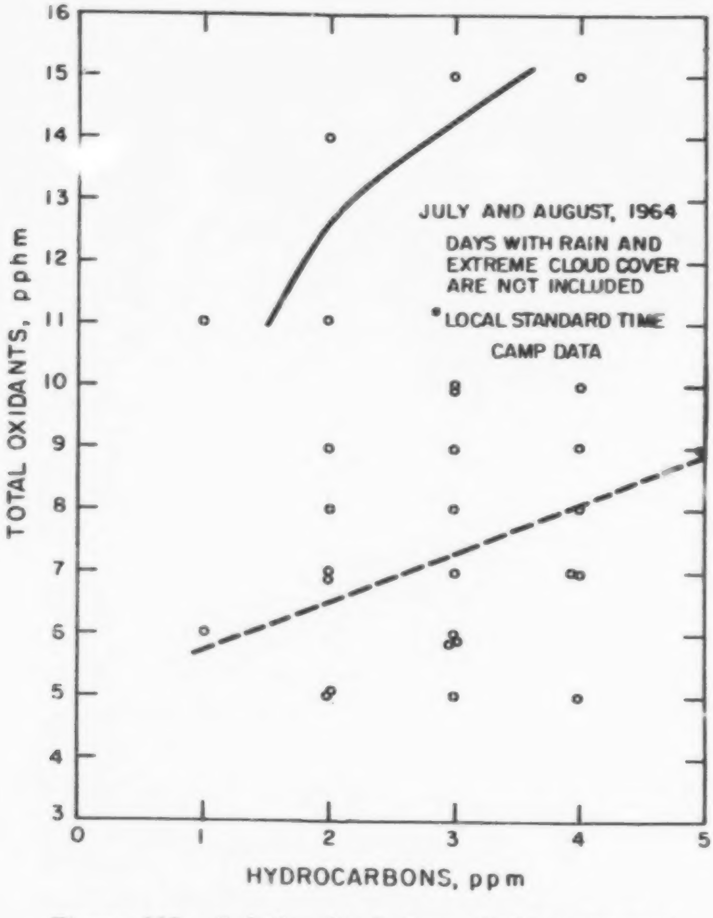

Figure 128. Relationship between hydrocarbons at 8 a.m.* and maximum total oxidants occurring between 10 a.m. and 4 p.m.

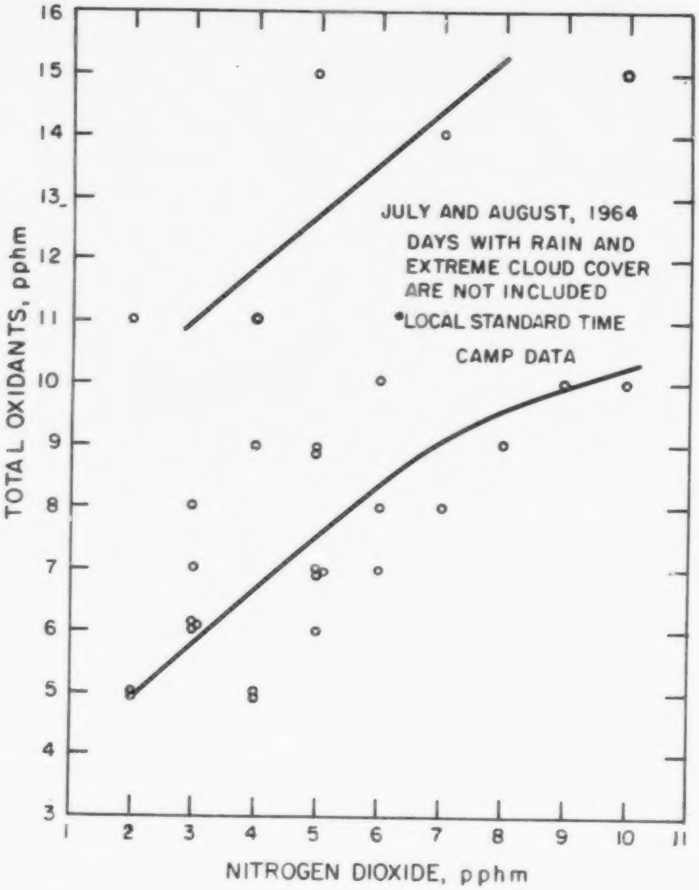

Figure 129. Relationship between maximum nitrogen dioxide from 7 to 11 a.m.* and maximum total oxidants from 10 a.m. to 4 p.m.

(Figure 130). The 2-month period had a large variety of wind speeds and directions, but the 5 high-oxidant days showed a preponderance of low wind speeds from the east-northeast and north-northeast. This leads to the possibility that oxidants,(photochemical or chemically related giving the same measurement response), produced in the Illinois part of the Study area were borne to the CAMP station and that conditions for oxidant production were more favorable there than indicated by measurements of hydrocarbons and nitrogen dioxide made at the CAMP station.

Additional analysis of the data indicated that increased wind speeds resulted in decreased oxidant levels. Although a relationship appeared to exist between concentrations of nitrogen dioxide and hydrocarbons, the practical value of the

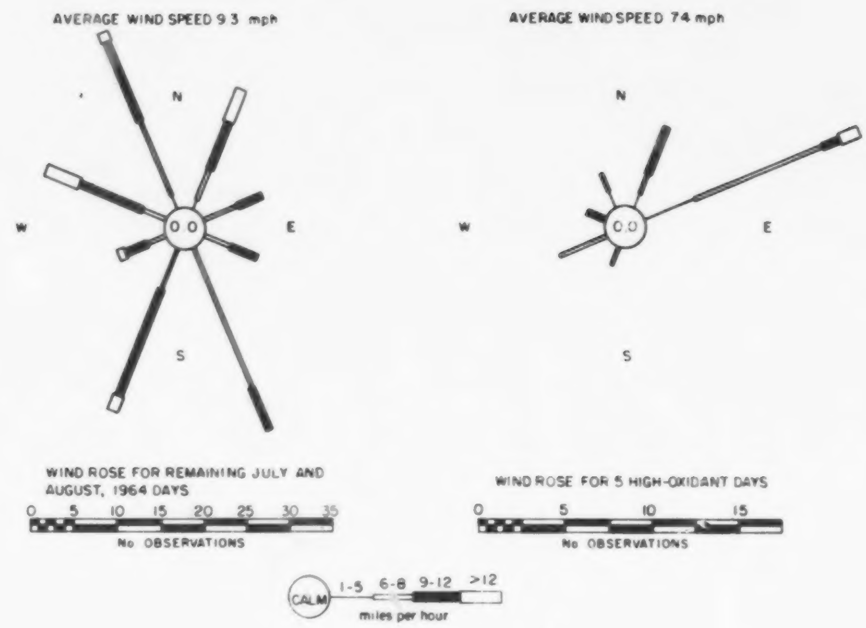

Figure 130. Wind roses based on hourly observations from 10 a.m. to 4 p.m. during oxidant study.

relationship for air-use-program development was not discernible because of unknown quantitative relationships between levels of nitrogen dioxide and hydrocarbons and the formation of oxidants and effects levels.

In conclusion, the formation and transport of oxidants in the Study area is complex. Some high oxidant levels do not relate to hours of the day when such levels would be expected. They are associated with southeast winds. Some relatively high levels are associated with the same measured levels of precursors that usually form much lower levels of oxidants. These are associated with winds from a northeasterly direction. The majority of oxidant levels, however, do show a fairly consistent relationship with precursors measured at the CAMP station.

MATERIALS DETERIORATION

Steel Panels

Results from the 35-station network in which steel panels were exposed for four periods from April 1963 through August 1964 are shown in Table 50. Arithmetic mean corrosion rates for all sites except 498-704 for the 2-, 4-, 8-, and 16-month exposure periods were 2.16, 3.86, 5.59, and 7.72 grams per panel, respectively. The

Table 50. CORROSION RATES AT SELECTED EXPOSURE SITES IN ST. LOUIS - EAST ST. LOUIS AREA

Site coordinates	Weight lost per 4- by 6-in. panel, grams							
	2-month exposure		4-month exposure		8-month exposure		16-month exposure	
	Top and bottom panel	Mean	Top and bottom panel	Mean	Top and bottom panel	Mean	Top and bottom panel	Mean
407-770	1.47 1.07	1.27	2.90 2.58	2.74	4.44 4.38	4.41	6.60 6.10	6.35
421-729	1.08 1.07	1.08	2.68 2.42	2.55	4.44 4.28	4.36	6.44 6.13	6.29
433-565	0.66 0.56	0.61	2.93 2.97	2.95	5.26 5.15	5.21	7.83 7.46	7.65
435-717	1.12 0.70	0.91	3.08 2.83	2.96	5.52 5.47	5.50	8.02 7.56	7.79
436-743	1.70 1.32	1.51	3.20 2.64	2.92	4.28 4.17	4.23	6.25 5.79	6.02
449-719	1.33 1.45	1.39	3.24 3.17	3.21	5.12 5.33	5.23	7.15 6.65	6.90
451-728	1.89 1.73	1.81	3.40 3.73	3.57	5.68 6.29	5.99	8.02 7.59	7.81
453-701	1.93 1.49	1.71	3.50 3.45	3.48	5.02 4.94	4.98	7.24 6.69	6.97
457-766	1.70 1.63	1.67	3.36 3.39	3.38	5.34 5.35	5.35	7.83 7.39	7.61
463-691	2.00 1.78	1.89	4.10 3.87	3.99	6.23 6.12	6.18	7.95 7.60	7.78
464-740	1.64 1.41	1.53	3.00 2.80	2.90	3.51 3.38	3.45	5.36 5.21	5.29
465-731	2.38 2.08	2.23	3.69 3.54	3.62	4.75 4.72	4.74	8.80 7.57	8.18
467-758	1.92 1.89	1.91	3.21 3.06	3.14	4.71 4.80	4.76	7.14 6.81	6.98
469-683	3.30 2.76	3.03	5.38 5.38	5.38	8.26 8.25	8.26	10.67 9.91	10.29
469-705	2.18 1.95	2.07	3.55 3.35	3.45	4.70 4.90	4.80	6.98 5.79	6.39
471-714	2.65 2.30	2.48	3.93 3.65	3.79	4.99 5.39	5.19	8.20 6.33	7.27
476-724	2.35 2.10	2.23	3.62 3.60	3.61	4.50 4.65	4.58	6.48 5.75	6.12
477-758	2.47 2.11	2.29	3.76 3.69	3.73	5.22 5.26	5.24	8.02 7.65	7.84
479-704	2.77 2.56	2.67	4.33 4.02	4.18	5.40 5.30	5.35	7.68 7.07	7.38
482-699	2.36 2.12	2.24	4.05 3.73	3.89	5.67 5.74	5.71	7.47 6.85	7.16
488-672	1.76 1.54	1.65	3.34 3.26	3.30	4.91 4.90	4.91	7.28 6.82	7.05
490-646	1.49 1.42	1.46	3.44 3.28	3.36	4.72 4.71	4.72	7.39 6.79	7.09
490-713	2.87 2.66	2.77	Lost 3.84	3.84	5.04 4.89	4.97	7.30 6.56	6.93
490-730	2.90 2.86	2.88	4.15 3.90	4.03	4.96 5.54	5.25	7.51 6.83	7.17
495-693	2.53 2.25	2.39	4.36 4.29	4.33	6.15 6.40	6.28	8.05 8.06	8.06
495-809	2.04 1.91	1.98	3.18 3.04	3.11	4.32 4.15	4.24	7.32 6.80	7.06
498-704	8.39 8.66	8.53	12.77 13.34	13.06	16.51 16.83	16.67	23.36 22.35	22.86
499-724	4.19 3.97	4.08	5.69 5.80	5.75	7.86 7.64	7.75	11.45 10.32	10.89
501-713	2.95 2.97	2.96	4.79 4.63	4.71	6.26 6.16	6.21	9.32 8.18	8.75
505-741	3.32 3.36	3.34	4.79 4.96	4.88	6.02 6.42	6.22	8.67 8.22	8.45
509-710	3.10 2.96	3.03	5.03 5.35	5.19	7.21 7.84	7.53	9.88 9.43	9.66
517-762	2.09 1.89	1.99	4.39 4.55	4.47	7.29 7.29	7.29	9.61 9.25	9.43
520-790	3.42 3.29	3.36	5.07 5.19	5.13	7.26 6.96	7.11	9.09 8.88	8.99
521-725	3.73 3.65	3.69	6.23 6.27	6.25	8.40 8.73	8.57	11.13 10.63	10.88
585-683	1.59 1.43	1.51	3.44 3.60	3.52	5.54 5.56	5.52	8.26 8.14	8.20

weight loss rate was 1.08, 0.97, 0.70, and 0.48 gram per month for the respective exposure periods. The tests demonstrated that the corrosion rate decreases with time and that corrosion products build up to provide a protective coating.

Figure 131, a map of the Study area, shows the geographical distribution of the 16-month mean corrosion rates. The actual locations of exposure sites are shown on Figure 2. Two nonurban sites, 433-565 and 585-683, are beyond the boundaries of the map.

Corrosion occurs at above-average rates in the high pollution areas. This is shown by comparison of corrosion maps, Figures 131 and 133, with isopleth maps for sulfation, sulfur dioxide, and particulates, measured by both the high-volume sampler and AISI sampler. The amount of increase in corrosion was as much as six-fold in the high pollution areas compared to the low pollution areas.

To test statistical correlations, dustfall and sulfation average values for each exposure period were plotted against the corresponding corrosion values. Annual mean pollution values were used for plotting 16-month data. Dustfall data, regardless of the exposure period, displayed no recognizable correlation or trend with corrosion. The correlation between sulfation and corrosion, however, was significant, 0.89 for the first 2-month exposure period. Figure 132 shows this graphically for the 2- and 16-month exposure periods. Data from site 498-704 were not included. Linear equations were derived for the sulfation-corrosion relationship and a statistical analysis was made. The analysis showed a correlation for the 2-month exposure period statistically significant at better than the 1 percent level, and for the 16-month exposure period statistically significant at the 1 percent level.

A second corrosion study was made using ten corrosion panel stations during the period December 1, 1964, through February 28, 1965. The sulfur oxides networks in operation during that period at these sites are described in other parts of this report.

Table 51 presents the corrosion-weight-loss results and corresponding sulfur dioxide and sulfation measurements for each of the ten exposure sites. Figure 133 shows the geographical distribution of the exposure sites and the corresponding 3-month corrosion rates. As in the earlier corrosion study, increased corrosion occurred in the areas of greater pollution. In this case, the cleanest site, 449-719, was located in the western suburbs of the metropolitan area. Compared to this "clean site," corrosion increased by 237 percent at the highest corrosion site, 499-706. Figures 134 and 135 show the relationships between the corrosion-weight-loss values and corresponding mean sulfur dioxide and sulfation measurements. Equations were derived for these relationships, and correlation coefficients were found to be

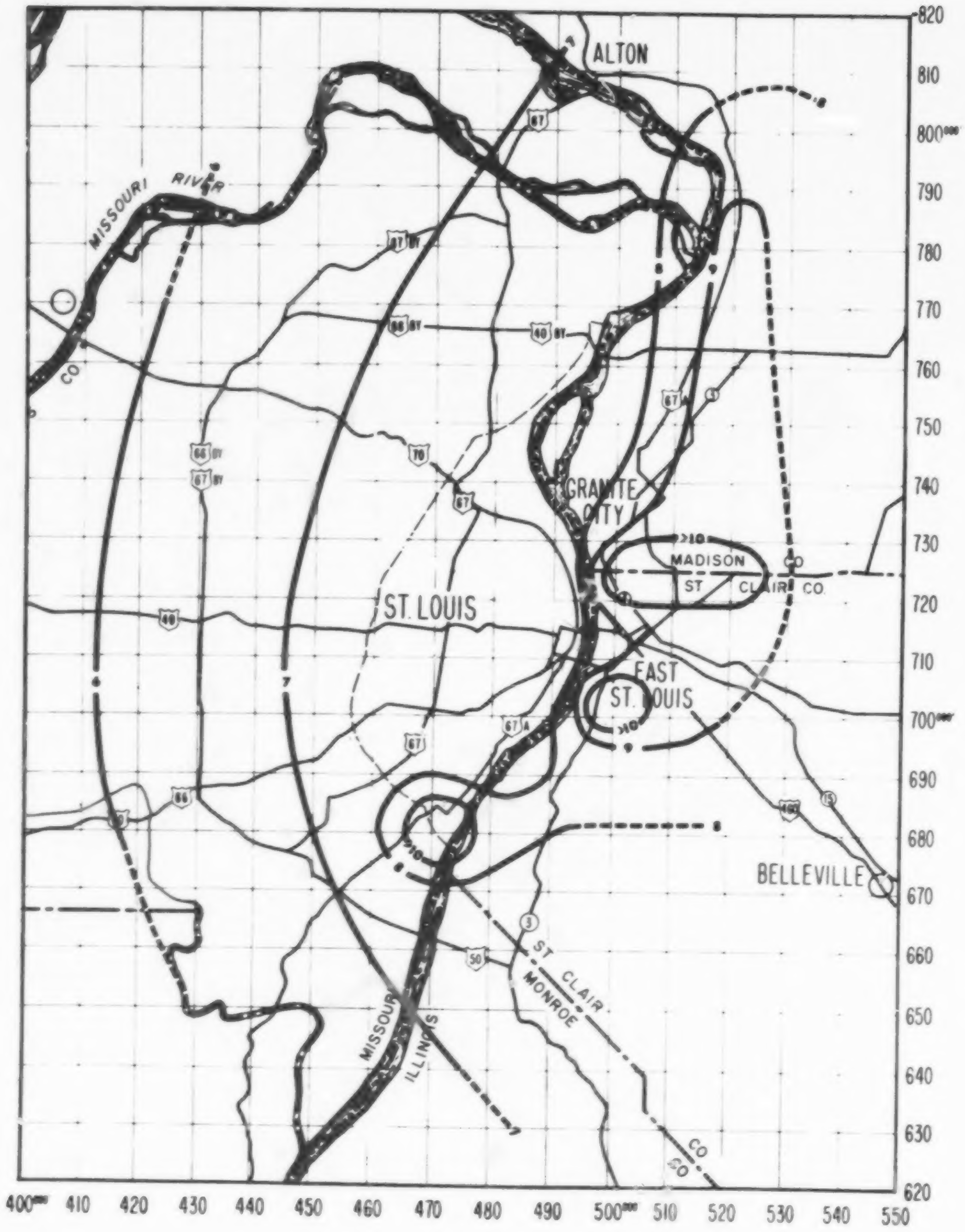
ALTON
MISSOURI RIVER
CO
67
67 BY
66 BY
40 BY
70
40
66
50
3
15
460
67 A
GRANITE CITY
MADISON CO
ST CLAIR CO.
ST. LOUIS
EAST ST. LOUIS
BELLEVILLE
ST CLAIR
MONROE
CO
CO
MISSOURI
ILLINOIS
10
10
10
9
8
8
7
6
820
810
800000
790
780
770
760
750
740
730
720
710
700000
690
680
670
660
650
640
630
620
400000
410
420
430
440
450
460
470
480
490
500000
510
520
530
540
550

Figure 131. Corrosion isopleths from 16-month study in St. Louis - East St. Louis Metropolitan Area (Numbers on isopleths indicate weight loss per panel in grams).

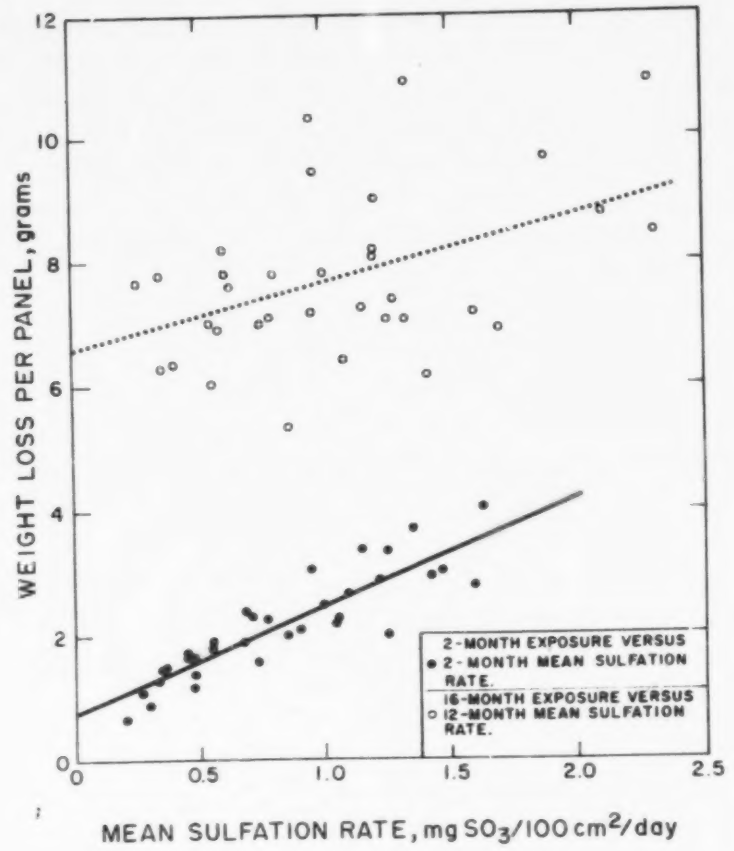

Figure 132. Relationship between corrosion and corresponding mean sulfation rate measured at selected sites in the St. Louis - East St. Louis Metropolitan Area.

approximately 0.90 for all relationships, significant at the 1 percent level. These findings are very similar to those of the earlier study, in which the correlation coefficient for corrosion and mean sulfation rates during the first 2-month exposure period at 34 of the 35 sites was 0.89.

Fabrics

Tests on cotton fabrics following exposure, although made primarily to develop a study and test methodology, led to the following observations:

1. There is a significant relationship between air pollution and the degradation of cotton fabrics. Fabrics exposed at the three sites with the highest levels of air pollution had the greatest strength losses.

2. The economic aspects of air-pollution-induced cloth degradation could be considerable. If a fabric article is serviceable until it still has one-third of its original strength, air pollution can reduce its effective service life to one-sixth or less of that of a similar article exposed in a clean area.

3. The time of initiating exposure studies is important. The samples exposed first in June degraded more rapidly than those started in December. Reduced chemical reaction rates resulting from lower temperatures and decreased solar intensity may be the cause.

4. Biological deterioration does not seem to be a major factor in fabric degradation in the St. Louis area.

Table 51. CORROSION AND CORRESPONDING SULFUR DIOXIDE AND SULFATION MEASUREMENTS OF THE 1964-65 ST. LOUIS 3-MONTH SULFUR DIOXIDE SAMPLING NETWORK

Site Coordinate	Weight loss per panel, grams		Mean	SO_2, ppm		Sulfation, mg SO_3/100 cm^2/day
	Top panel	Bottom panel		2-hourly samples	24-hourly samples	
449-719	3.63	3.77	3.70	0.027	0.021	1.61
468-724	7.84	7.58	7.71	0.080	0.069	2.27
479-738	6.86	6.57	6.72	0.052	0.048	1.84
481-596	4.95	5.14	5.05	0.034	0.028	2.01
490-713	6.99	6.91	6.95	0.059	0.049	2.51
498-729	8.72	8.36	8.54	0.066	0.057	2.63
499-706	12.53	12.45	12.49	0.128	0.106	4.46
509-710	8.74	7.88	8.31	0.068	0.052	2.96
509-751	7.60	7.47	7.54	0.032	0.026	2.46
527-702	4.08	4.40	4.24	0.030	0.029	2.19

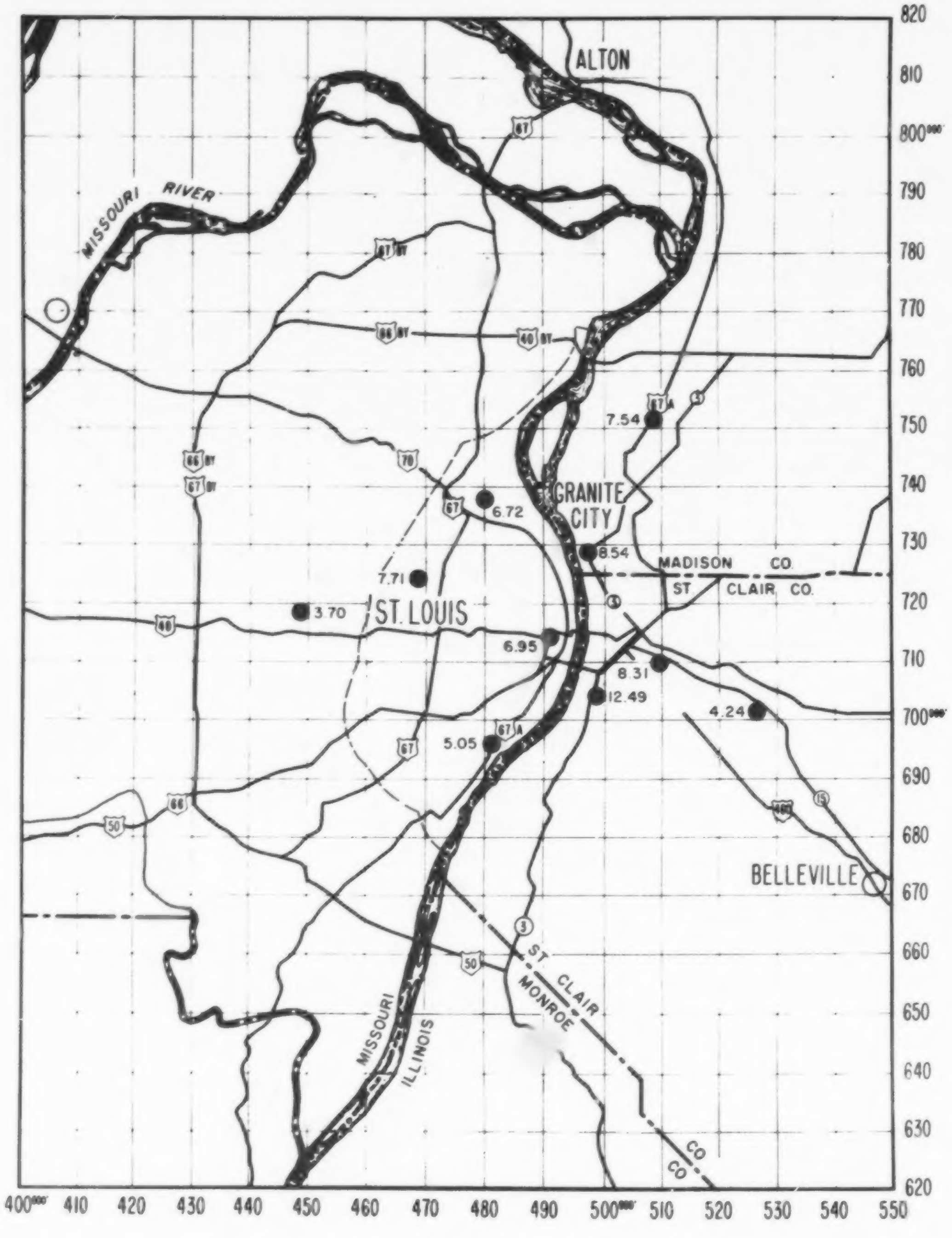
ALTON
MISSOURI RIVER
67
67 BY
66 BY
40 BY
66 BY
67 BY
70
67
67 A
GRANITE CITY
7.54
6.72
8.54
7.71
3.70
ST. LOUIS
6.95
8.31
12.49
4.24
5.05
MADISON CO.
ST. CLAIR CO.
40
66
50
50
3
460
15
BELLEVILLE
ST. CLAIR
MONROE
CO
CO
MISSOURI
ILLINOIS
820
810
800
790
780
770
760
750
740
730
720
710
700
690
680
670
660
650
640
630
620
400
410
420
430
440
450
460
470
480
490
500
510
520
530
540
550

Figure 133. Exposure sites for 3-month (Dec 1964 - Feb 1965) corrosion study in St. Louis - East St. Louis Metropolitan Area (Numbers at each site indicate weight loss per panel in grams).

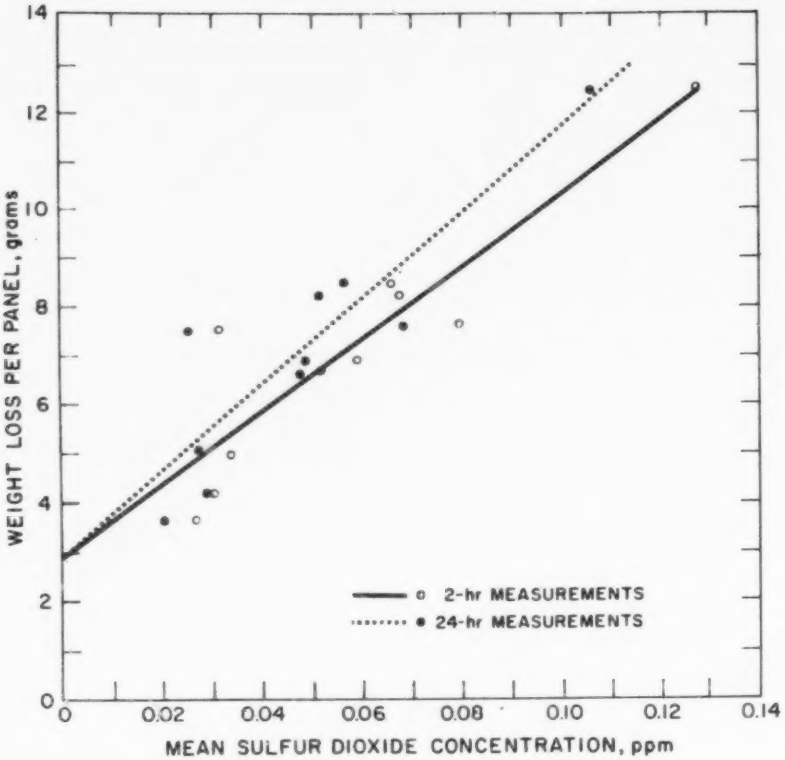

Figure 134. Relationship between corrosion of mild steel and corresponding mean sulfur dioxide concentration for 3-month (Dec 1964 - Feb 1965) exposure at 10 St. Louis sites.

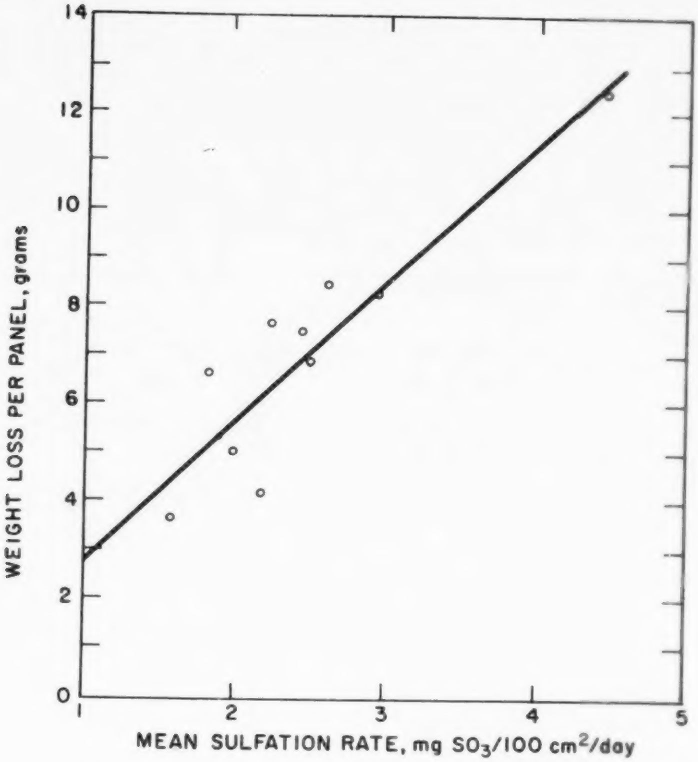

Figure 135. Relationship between corrosion of mild steel and corresponding monthly mean sulfation rate for 3-month (Dec 1964 - Feb 1965) exposure at 10 St. Louis sites.

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APPENDIX

AIR QUALITY MEASUREMENT STATIONS EXCEPT SULFUR DIOXIDE WINTER NETWORKS

Ascending order of site coordinate numbers

Site Coordinate	Address	Station Name	City & State
407-770	Metropolitan Life Ins. Co. 814 Clay St.	St. Charles	St. Charles, Mo.
421-729	11720 Olive St. Road	Creve Coeur	St. Louis, Mo. 63141
432-715	St. Louis Co. Pub. Library 1640 S. Lindbergh Blvd.	Kirkwood	St. Louis, Mo. 63124
433-565	Festus Jr. High School 711 W. Main St.	Festus	Festus, Mo.
435-589	Mueller Lumber Co.	Pevely	Pevely, Mo.
435-717	N & K Associates 9827 Clayton Road	Ladue	St. Louis, Mo. 63124
436-743	West Overland Fire Dist. 2831 Ashby Road	Overland	St. Louis, Mo. 63114
438-689	42 Crestwood Plaza	Crestwood	St. Louis, Mo. 63126
449-719	801 S. Brentwood	Brentwood	St. Louis, Mo. 63105
451-728	University City Fire Station No. 3 1045 North & South Road	University City	St. Louis, Mo. 63130
453-701	St. Michael School 76730 Sutherland Ave.	Shrewsbury	St. Louis, Mo. 63119
457-766	Florissant School Dist. Bus Garage 1894 New Florissant Road	Florissant	St. Louis, Mo. 63135
458-715	6420 Clayton Road	St. Mary Hospital	St. Louis, Mo. 61317
463-691	Schnuck Super Market 7450 Hampton Road	Schnuck	St. Louis, Mo. 63109
464-740	Walgreen Drug Store 1 Normandy Shopping Center	Northwoods	St. Louis, Mo. 63124
465-731	Central Hardware Co. 6250 Easton Ave.	Wellston	St. Louis, Mo. 63133
467-758	10132 W. Florissant	Dellwood	St. Louis, Mo. 63136
468-665	Veterans Admin. Hospital Lindbergh at Mississippi R.	Jefferson Barracks	St. Louis, Mo. 63125
469-683	Lemay Bank and Trust 152 Lemay-Ferry Road	Lemay	St. Louis, Mo. 63125
469-705	C. Rallo Construction Co. 5000 Kemper Ave.	Rallo	St. Louis, Mo. 63139

Site Coordinate	Address	Station Name	City & State
469-749	Peoples 905 Liquor Store 7445 W. Florissant	Jennings	St. Louis, Mo. 63136
469-750	Northland Shopping Center Lucas & Hunt at W. Florissant	Northland	St. Louis, Mo. 63136
470-718	Steinberg Skating Rink Forest Park	Steinberg	St. Louis, Mo.
471-714	St. Louis University High School, 4970 Oakland Ave.	St. Louis U.H.S.	St. Louis, Mo. 63110
472-680	8900 S. Broadway	Aero Charts	St. Louis, Mo. 63129
476-724	1421 N. Taylor	Visitation School	St. Louis, Mo. 63113
477-758	Bell Telephone Co. 10024 Duke Drive, Jennings	Moline Acres	St. Louis, Mo. 63136
479-704	St. Elizabeth Academy 3401 Arsenal St.	St. Elizabeth	St. Louis, Mo. 63118
480-725	2601 Whittier St.	Homer G. Phillips Hosp.	St. Louis, Mo. 63115
481-698	3919 Iowa	Iowa	St. Louis, Mo. 63118
482-697	3933 S. Broadway	Alexian Brothers Hosp.	St. Louis, Mo. 63111
482-699	3641 S. Jefferson	A. & P.	St. Louis, Mo. 63118
485-714	2810 Clark St.	St. L. Testing Lab.	St. Louis, Mo. 63103
488-672	600 Louisiana	Dupo Comm'l High Schl.	Dupo, Ill.
489-728	1901 Penrose	Penrose Police Sta. 5th District	St. Louis, Mo. 63107
490-646	119 Cherry St.	Columbia Fire Dept.	Columbia, Ill.
490-713	1300 Market St.	Municipal Cts. Bldg.	St. Louis, Mo. 63103
490-730	4560 N. 2nd St.	Western Trucking Co.	St. Louis, Mo. 63147
494-703	Monsanto Terminal Mississippi River	Monsanto Terminal	Monsanto, Ill.
495-693	Rts. 157 & 3	Parks College of St.Louis University - Mercury Hall	Centreville, Ill.
495-709	MacArthur Bridge	MacArthur	State line - Mo.-Ill.
495-809	101 E. 3rd St.	Alton City Hall	Alton, Ill.
498-704	Highway 3	Young-Wheeler Lbr. Co.	Monsanto, Ill.
499-700	2897 Monsanto Ave.	Monsanto Village Hall	Monsanto, Ill.
499-724	4th & Washington	Brooklyn Fire Dept.	Lovejoy, Ill.
501-713	7 Collinsville Ave.	E. St. Louis City Hall	E. St. Louis, Ill.
505-740	2000 Edison St.	Granite City City Hall	Granite City, Ill.
505-740	20th & State	Granite City Steel Office	Granite City, Ill.
507-741	23rd & Madison	Granite City Fire Station	Granite City, Ill.
509-710	638 N. 20th St.	East Side Health District	E. St. Louis, Ill.
517-692	5900 Bond Ave.	Centreville Twp. Gen'l Hosp.	Centreville, Ill.

Site Coordinate	Address	Station Name	City & State
517-762	5429 Maryville Rd.	Cedar Park Confectionery	Granite City, Ill.
520-790	507 N. Delmar	Hartford Fire Department	Hartford, Ill.
520-798	Wood River City Hall & Fire Dept.	Wood River	Wood River, Ill.
521-725	Canteen School Kingshighway & Hwy. 40	Canteen	Canteen, Ill.
534-702	French Village Dist. HW. Garage 9300 St. Clair	French Village	E. St. Louis, Ill.
554-668	U.S. Army Reserve Center 500 South Belt East	Belleville	Belleville, Ill.
585-683	Scott Air Force Base Provost Marshall's office	Scott AFB	Scott Air Force Base, Illinois

AIR QUALITY MEASUREMENT STATIONS EXCEPT SULFUR DIOXIDE WINTER NETWORKS

Alphabetical order by name

Station Name	Address	Site Coordinate	City & State
A. & P.	3641 S. Jefferson	482-699	St. Louis, Mo. 63118
Aero Charts	8900 S. Broadway	472-680	St. Louis, Mo. 63129
Alexian Brothers Hospital	3933 S. Broadway	482-697	St. Louis, Mo. 63111
Alton	Alton City Hall 101 E. 3rd St.	495-809	Alton, Ill.
Belleville	U.S. Army Reserve Ctr. 500 South Belt. East.	554-668	Belleville, Ill.
Brentwood	801 S. Brentwood	449-719	St. Louis, Mo. 63105
Brooklyn	Brooklyn Fire Dept. 4th & Washington	499-724	Lovejoy, Ill.
Canteen	Canteen School Kingshighway & Hwy. 40	521-725	Canteen, Ill.
Cedar Park	Cedar Pk. Confect'y 5429 Maryville Rd.	517-762	Granite City, Ill.
Centreville	Centreville Twp. General Hospital 5900 Bond Ave.	517-692	Centreville, Ill.
Columbia	Columbia Fire Dept. 119 Cherry St.	490-646	Columbia, Ill.
Creve Coeur	11720 Olive St. Road	421-729	St. Louis, Mo. 63141
Crestwood	42 Crestwood Plaza	438-689	St. Louis, Mo. 63126
Dellwood	10132 W. Florissant	467-758	St. Louis, Mo. 63136
Dupo	Dupo Comm'l High Schl. 600 Louisiana	488-672	Dupo, Ill.
E. St. Louis City Hall	7 Collinsville Ave.	501-713	East St. Louis, Ill.
East Side Health Dist.	638 N. 20th St.	509-710	East St. Louis, Ill.
Festus	Festus Jr. High Schl. 711 W. Main St.	433-565	Festus, Mo.
Florissant	Florissant School Dist. Bus Garage 1894 New Florissant Rd.	457-766	St. Louis, Mo. 63135
French Village	French Village Dist. Hwy. Garage 9300 St. Clair	534-702	E. St. Louis, Ill.
Granite City City Hall	2000 Edison St.	505-740	Granite City, Ill.

Station Name	Address	Site Coordinate	City & State
Granite City Fire Sta.	23rd & Madison	507-741	Granite City, Ill.
Granite City Steel Office	20th & State	505-740	Granite City, Ill.
Hartford	Hartford Fire Dept. 507 N. Delmar	520-790	Hartford, Ill.
Homer G. Phillips Hospital	2601 Whittier St.	480-725	St. Louis, Mo. 63115
Iowa	3919 Iowa	481-698	St. Louis, Mo. 63118
Jefferson Barracks	V. A. Hospital Lindbergh at Mississippi River	468-665	St. Louis, Mo. 63125
Jennings	Peoples 905 Liquor Store 7445 W. Florissant	469-749	St. Louis, Mo. 63136
Kirkwood	St. Louis County Public Library 1640 S. Lindbergh Blvd.	432-715	St. Louis, Mo. 63124
Ladue	N&K Associates 9827 Clayton Road	435-717	St. Louis, Mo. 63124
Lemay	Lemay Bank & Trust 152 Lemay Ferry Rd.	469-683	St. Louis, Mo. 63125
MacArthur	MacArthur Bridge	495-709	Missouri - Illinois State line
Moline Acres	Bell Telephone Co. 10024 Duke Drive	477-758	St. Louis, Mo. 63136
Monsanto	Young-Wheeler Lbr. Co. Highway 3	498-704	Monsanto, Ill.
Monsanto Terminal	Mississippi River	494-703	Monsanto, Ill.
Monsanto Village	Monsanto Village Hall 2897 Monsanto Ave.	499-700	Monsanto, Ill.
Municipal Courts	Municipal Court Bldg. 1300 Market St.	490-713	St. Louis, Mo. 63103
Northland	Northland Shopping Center Lucas-Hunt at W. Florissant	469-750	St. Louis, Mo. 63136
Northwoods	Walgreen Drug Store 1 Normandy Shopping Ctr.	464-740	St. Louis, Mo. 63124
Overland	West Overland Fire Dist. 2831 Ashby Road	436-743	St. Louis, Mo. 63114
Parks College	Parks College of St. Louis University Mercury Hall, Rts. 157 & 3	495-693	Centreville, Ill.
Penrose	Police Station (5th Dist.) 1901 Penrose	489-728	St. Louis, Mo. 63107
Pevely	Mueller Lumber Co.	435-589	Pevely, Mo.
Rallo	C. Rallo Construction Co. 5000 Kemper Ave.	469-705	St. Louis, Mo. 63139

Station Name	Address	Site Coordinate	City & State
St. Charles	Metropolitan Life Ins. Co., 814 Clay Street	407-770	St. Charles, Missouri
St. Elizabeth	St. Elizabeth Academy 3401 Arsenal St.	479-704	St. Louis, Mo. 63118
St. Louis Testing Lab.	2810 Clark St.	485-714	St. Louis, Mo. 63103
St. Louis U.H.S.	St. Louis University High School 4970 Oakland Ave.	471-714	St. Louis, Mo. 63110
St. Mary Hospital	6420 Clayton Road	458-715	St. Louis, Mo. 63117
Schnuck	Schnuck Super Market 7450 Hampton Road	463-691	St. Louis, Mo. 63109
Scott Air Force Base	Provost Marshall's Office	585-683	Scott A.F. Base, Illinois
Shrewsbury	St. Michael School 76730 Sutherland Ave.	453-701	St. Louis, Mo. 63119
Steinberg	Steinberg Skating Rink Forest Park	470-718	St. Louis, Mo.
University City	University City Fire Station No. 3 1045 North & South Rd.	451-728	St. Louis, Mo. 63130
Visitation	Visitation School 1421 N. Taylor	476-724	St. Louis, Mo. 63113
Wellston	Central Hardware Co. 6250 Easton Ave.	465-731	St. Louis, Mo. 63133
Western	Western Trucking Co. 4560 N. 2nd St.	490-730	St. Louis, Mo. 63147
Wood River	Wood River City Hall & Fire Dept.	520-798	Wood River, Ill.

SULFUR DIOXIDE WINTER NETWORK STATIONS

By Ascending Site-Coordinate Numbers

Site Coordinate	Address and Location	Station No.	State
449-719	Northwest corner of St. Louis County Health Building, Brentwood Boulevard (Brentwood).	33	Missouri
450-703	Power pole on southwest corner of Newport and Summit Avenues (Webster Groves).	35	Missouri
453-735	Power pole with street light, north end of Vinita Drive, near intersection of Vinita and Monroe Drives (Vinita Terrace).	31	Missouri
466-742	Power pole with street light, southeast of the intersection of Crestland and Florian Streets (Northwoods).	29	Missouri
467-697	Power pole with transformer No. 52/10 in alley (approximately 50 ft.) east of Brannon Avenue between Itaska and Delor Streets.	37	Missouri
468-718	Power pole near creek on north side of lower parking lot east of Municipal Theater in Forest Park.	19	Missouri
468-724	Power pole on northwest corner of Belt and Cates Avenue.	17	Missouri
471-689	Power pole with transformer, south side of street in front of 3728 Blow Street, between Eugenia and Field Streets.	39	Missouri
472-707	Power pole with transformer No. 4518, on north side of alley (just off Alfred Street) between Magnolia Avenue and Tower Grove Place.	21	Missouri
474-756	Power pole No. 2108, south side of Kappel Drive, off Halls Ferry Road. Second pole east of Nolte Avenue (Moline Acres).	27	Missouri
478-723	Power pole in alley at northwest corner of lot behind 4215 West Page Boulevard, between Whittier and Pendleton Avenues.	49	Missouri
479-738	Power pole in alley at southwest corner of lot behind 5449 Geraldine Street, north of Harney Street.	15	Missouri
480-682	Power pole with street light No. 86, northwest side of South 7th Street, southwest of school playground (E. Carondelet).	40	Illinois
480-712	Power pole west side of Rankin Street, at alley between Caroline and Rutger Streets.	11	Missouri
481-696	Power pole on southwest corner of Ohio and Gasconade Streets.	23	Missouri

Site Coordinate	Address and Location	Station Number	State
486-718	Power pole with transformer, northeast of intersection Leffingwell and Cole Streets. Vacant lot on corner.	5	Missouri
487-706	Power pole with transformer No. 2205; first pole south of Ann Street in alley between 11th and 12th Streets.	13	Missouri
488-730	Power pole with transformer south side of street in front of 1914 Obear Street, between 20th and Blair Streets.	7	Missouri
490-713	North side of CAMP Station, 12th and Clark Streets.	3	Missouri
490-759	Power pole with street light, north side of Cameron Street, west of Crawford Street (Riverview).	25	Missouri
491-692	Power pole with transformer and light, southeast corner of 4th and Green Streets intersection (Cahokia).	26	Illinois
494-721	Power pole with transformer, between 1st and 2nd Street, south side of Ryerson Parking lot.	1	Missouri
498-696	Power pole No. 1702, in front of 217 Julian Street at north end of side street (Cahokia).	24	Illinois
498-717	Power pole with street light No. 609 on east side of Front Street, 2000 feet north of Broadway (E. St. Louis).	2	Illinois
498-729	Power pole with street light, 50 yards east of 3rd Street, north side of Hampden. (Venice, Ill.).	4	Illinois
499-706	Power pole in school yard east of Easterly Elementary School, 1060 Liberty Street, approximately 150 feet from street. (E. St. Louis).	10	Illinois
499-743	Power pole with street light, southwest of Cayuga Street and McCasland Ave. (Granite City, Ill.).	16	Illinois
501-713	Power pole with transformer in E. St. Louis Municipal parking lot, behind City Hall. Pole furnishes power to 17 Main Street (E. St. Louis).	8	Illinois
502-736	Power pole with street light, between 10th and 12th Streets on east side of State Street. About 200 yards north of 10th Street.	18	Illinois
503-723	Power pole 40 feet north of Big Bend Road, next to railroad; furnishes power to RR Signal 211 (National City).	6	Illinois
509-700	Power pole at end of South 36th Street, off (Highway 13) Bond Avenue (E. St. Louis).	14	Illinois

Site Coordinate	Address and Location	Station No.	State
509-710	Power pole south of East Side Health District 628 N. 20th Street, E. St. Louis; supplies power to building. Approximately 100 feet east of street. (E. St. Louis).	12	Illinois
509-720	Power pole with transformer, supplying power to Radio Station KATZ off Alternate 67 north of Highway 70 (St. Clair County).	20	Illinois
509-751	Power pole with transformer, furnished to Box 1012 Pontoon Rd., Granite City, Ill. ¼-mile east of Highway Alternate 67 (Madison County).	28	Illinois
513-742	Power pole No. 2832, south side of street in front of 2832 E. 25th Street, block east of Nameoki Avenue (Granite City).	30	Illinois
515-690	Power pole with transformer No. 15236, west side and in front of 6210 Church Street (Centreville).	38	Illinois
518-716	Power pole with street light, northeast of Lincoln Avenue and 45th Street intersection (E. St. Louis).	22	Illinois
521-733	Power pole No. 18397 supplying electricity to the pink trailer house with the painted wood rail fence at the end of the right fork of Bend Road (Horse Shoe Lake area).	32	Illinois
527-702	Power pole on north side of Eureka Street, at alley between 77th and 78th Streets (E. St. Louis).	36	Illinois
533-717	Power pole with transformer, south side and in front of 8500 Forest Blvd. (St. Clair County).	34	Illinois

SULFUR DIOXIDE WINTER NETWORK STATIONS

By Numerical Station Numbers

Station No.	Address and Location	Site Coordinate	State
1	Power pole with transformer, between 1st and 2nd Streets, south side of Ryerson Parking Lot.	494-721	Missouri
2	Power pole with street light No. 609 on east side of Front Street, 2000 feet north of Broadway. (E. St. Louis).	498-717	Illinois
3	North side of CAMP Station, 12th and Clark Streets.	490-713	Missouri
4	Power pole with street light, 50 yards east of 3rd Street, north side of Hampden. (Venice, Ill.).	498-729	Illinois
5	Power pole with transformer, northeast of intersection Leffingwell and Cole Streets. Vacant lot on corner.	486-718	Missouri
6	Power pole 40 feet north of Bend Road next to railroad; furnishes power to RR Signal 211 (National City).	503-723	Illinois
7	Power pole with transformer, south side of street in front of 1914 Obear Street, between 20th and Blair Streets.	488-730	Missouri
8	Power pole with transformer in E. St. Louis Municipal parking lot, behind City Hall. Pole furnishes power to 17 Main Street (E. St. Louis).	501-713	Illinois
9	Installed but not operable. Moved to Site 49.		Missouri
10	Power pole in school yard east of Easterly Elementary School, 1060 Liberty Street, approximately 150 feet from street. (E. St. Louis).	499-706	Illinois
11	Power pole west side of Rankin Street, at alley between Caroline and Rutger Streets.	480-712	Missouri
12	Power pole south of East Side Health District, 628 N. 20th Street, E. St. Louis; supplies power to building. Approximately 100 feet east of street. (E. St. Louis).	509-710	Illinois
13	Power pole with transformer No. 2205; first pole south of Ann Street in alley between 11th and 12th Streets.	487-706	Missouri
14	Power pole at end of South 36th Street, off (Highway 13) Bond Avenue. (E. St. Louis).	509-700	Illinois
15	Power pole in alley at southwest corner of lot behind 5449 Geraldine Street, north of Harney Street.	479-738	Missouri
16	Power pole with street light, southwest of Cayuga Street and McCasland Avenue. (Granite City).	499-743	Illinois

Station No.	Address and Location	Site Coordinate	State
17	Power pole on northwest corner of Belt and Cates Avenue.	468-724	Missouri
18	Power pole with street light, between 10th and 12th Streets on east side of State Street. About 200 yards north of 10th Street.	502-736	Illinois
19	Pole near creek on north side of lower parking lot east of Municipal Theater in Forest Park.	468-718	Missouri
20	Power pole with transformer, supplying power to Radio Station KATZ off Alternate 67 north of Highway 70 (St. Clair County).	509-720	Illinois
21	Power pole with transformer No. 4518, on north side of alley (just off Alfred Street) between Magnolia Avenue and Tower Grove Place.	472-707	Missouri
22	Power pole with street light northeast of Lincoln Avenue and 45th Street intersection (E. St. Louis).	518-716	Illinois
23	Power pole on southwest corner of Ohio and Gasconade Streets.	481-696	Missouri
24	Power pole No. 1702, in front of 217 Julian Street at north end of side street (Cahokia).	498-696	Illinois
25	Power pole with street light, north side of Cameron Street, west of Crawford Street (Riverview).	490-759	Missouri
26	Power pole with transformer and light, southeast corner of 4th and Green Streets intersection (Cahokia).	491-692	Illinois
27	Power pole No. 2108, south side of Kappel Drive, off Halls Ferry Road. Second pole east of Nolte Avenue (Moline Acres).	474-756	Missouri
28	Power pole with transformer, furnished to Box 1012 Pontoon Road, Granite City, Ill. ¼-mile east of Highway Alternate 67 (Madison County).	509-751	Illinois
29	Power pole with street light, southeast of the intersection of Crestland and Florian Streets (Northwoods).	466-742	Missouri
30	Power pole No. 2832, south side of street in front of 2832 E. 25th Street, block east of Nameoki Avenue (Granite City).	513-742	Illinois
31	Power pole with street light, north end of Vinita Drive, near intersection of Vinita and Monroe Drives (Vinita Terrace).	453-735	Missouri
32	Power pole No. 18397 supplying electricity to the pink trailer house with the painted wood rail fence at the end of the right fork of Bend Road (Horse Shoe Lake area).	521-733	Illinois
33	Northwest corner of St. Louis County Health Building, Brentwood Boulevard (Brentwood).	449-719	Missouri
34	Power pole with transformer, south side and in front of 8500 Forest Boulevard (St. Clair County).	533-717	Illinois

Station No.	Address and Location	Site Coordinate	State
35	Power pole on southwest corner of Newport and Summit Avenues (Webster Groves).	450-703	Missouri
36	Power pole on north side of Eureka Street at alley between 77th and 78th Streets (E. St. Louis).	527-702	Illinois
37	Power pole with transformer No. 52/10 in alley (approximately 50 feet) east of Brannon Avenue, between Itaska and Delor Streets.	467-697	Missouri
38	Power pole with transformer No. 15236, west side and in front of 6210 Church Street (Centreville).	515-690	Illinois
39	Power pole with transformer, south side of street in front of 3728 Blow Street, between Eugenia and Field Streets.	471-689	Missouri
40	Power pole with street light No. 86, northwest side of South 7th Street, southwest of school playground (E. Carondelet).	480-682	Illinois
49	Power pole in alley at northwest corner of lot behind 4215 West Page Boulevard, between Whittier and Pendleton Avenues.	478-723	Missouri

END